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Ceramic Abstracts and the Bulletin

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

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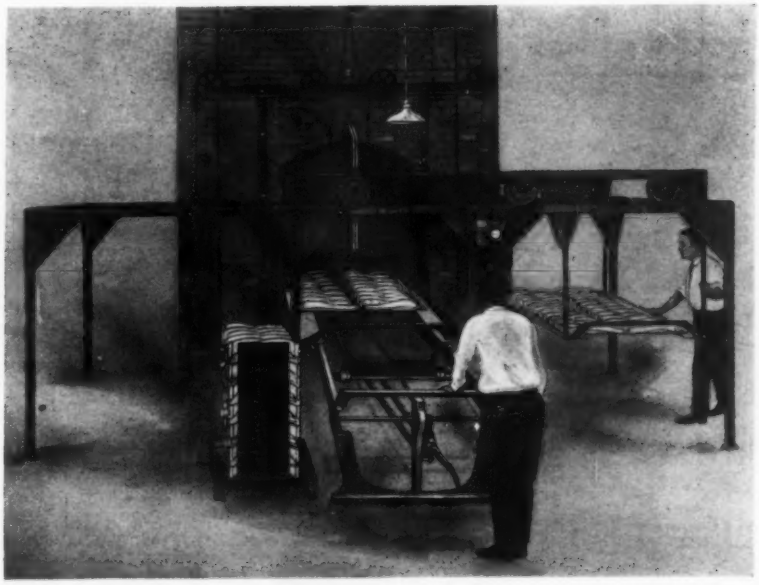

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ORIGINAL PAPERS

TESTS ON SOME SAGGER CLAYS AND BODIES[1]

By Robert Twells, Jr.

ABSTRACT

Tests on the Sagger Clays.—Bars were made from three typical sagger clays without the addition of grog. After burning at cone $10^1/_2$ these bars were tested for *linear shrinkage, transverse strength, dry and fired, absorption of moisture,* and *dye penetration.*

Tests on Fire Clay-Grog Sagger Bodies.—Two series of bodies were made up into bars. After being burned at cone $10^1/_2$ the bars were tested for *linear shrinkage, transverse strength, dry and fired,* and *resistance to heat changes.* The *best body* of this type tested was No. 5 which had the composition: No. 8 buff clay, 29.8%; No. 1 fine clay, 18.2%; grog, 6-to 20-mesh, 42.0%; grog, 20-mesh and finer, 10.0%. As a *plant test* 100 saggers were made from this body. At the end of five fires, three were broken, and fifteen were slightly cracked.

Tests on Some Refractory Bodies not Commonly Used for Saggers.—Three bodies were made into bars, fired to cone $10^1/_2$ and tested as before. Two proved much superior to those of the fire clay-grog type. Their compositions are:

No.	12	No.	14
Georgia Kaolin	35%	Kentucky Ball Clay No. 4	40%
Tennessee Ball Clay No. 5	10%	Medium Sized Carborundum (fire-sand)	60%
Grog, 10–40 mesh	55%		
	100%		100%

[1] A report of some of the work done during the autumn of 1920 in the Research Laboratory and Porcelain Department of the General Electric Company at Schenectady, N. Y.

Read before the Whitewares Division, Pittsburgh Meeting, February, 1923.

These bodies, especially No. 14, are of types ordinarily considered too expensive (their first cost) for general use. Are such bodies actually more expensive, when the cost is figured on the basis of the lives of the saggers? They can be determined only by making plant trials of a large number of saggers, determining the relative "cost per fire."

Introduction

At the St. Louis meeting of the AMERICAN CERAMIC SOCIETY, Mr. Treischel[1] submitted a tentative program for coöperative research in the investigation of sagger making problems. Several members differed with him in regard to the method of investigation to be followed. All, however, agreed with him as to the desirability of a complete and thorough study of the whole field. Mr. Bleininger[2] suggested that the first step should be a survey of the present sagger situation, and a careful review of all previous work. It is to assist in the latter work that this article is submitted.

The primary object of this investigation was to develope a relatively cheap sagger body which would have a longer life in production than the regular mix.

Laboratory Tests of the Sagger Clays Used without the Addition of Grog[3]

1. Sources of the Clays

No. 8 Buff Clay—a plastic fire clay from Edgar Bros. Co., Metuchen, N. J.

No. 1 Fine Clay—a plastic fire clay from Crossman Co., South Amboy, N. J.

No. 1 White Sandy Clay—a short sandy clay from Ostrander Fire Brick Co., Ostrander, N. J.

These clays were picked for these experiments because they are typical commercial sagger clays, relatively cheap, and available in quantity.

Compositions of Test Pieces

Designation	B	F	BS	BF
No. 8 Buff Clay	100%	.....	62%	62%
No. 1 Fine Clay	.....	100%	....	38%
No. 1 White Sandy Clay	.....	.....	38%	....
	100%	100%	100%	100%

Method of Forming, Drying, and Firing the Test Pieces.—The clays were each ground to pass 20-mesh, weighed, mixed carefully dry; then

[1] C. C. Treischel, "Coöperative Research on Sagger Mixtures and Manufacture," *Bull. Amer. Ceram. Soc.*, **1** [7], 101 (1922).

[2] A. V. Bleininger, *ibid.*, **1** [7], 105 (1922).

[3] Suggested by "The Control of Sagger Mixtures," V. S. Schory, *Jour. Amer. Ceram. Soc.*, **2** [9], 747 (1919).

moistened, and wedged thoroughly. Ten test bars, $1 \times 1/2 \times 4 1/2$ inches, were pressed from each. Shrinkage marks $2 1/2$ inches apart were stamped on both sides of each test piece as soon as it was removed from the mold. The test pieces were dried in a Proctor Humidity Dryer in thirty hours. Five test pieces from each body were fired in a Didier-March Tunnel Kiln[1] to a temperature of cone $10 1/2$.

Methods of Making Tests.—Linear drying and total shrinkages were determined. Measurements were taken on both sides of each test piece to avoid errors due to warpage. Modulus of rupture tests were made on five unfired and five fired test pieces from each material in a Riehle Testing Machine. A span of $3 1/2$ inches between knife edges was used. The pieces were broken with the flat side down. Absorption test was made on three broken fired bars of each, boiling during the 1st, 25th, 50th, 75th, and 100th hours. Dye test was made on the fired pieces soaking in dye solution for 16 hours under a pressure of 250 pounds per square inch.

Results of the Tests

	Av. linear shrinkage per cent of wet length		Av. modulus of rupture lbs. per sq. in.		
Designation	Drying	Burning	Total	Dry	Fired
B.	5.0	9.0	14.0	150	5500
F.	6.0	12.5	10.5	80	4400
BS.	6.0	6.0	12.0	114	2340
BF.	6.0	10.0	16.0	82	7325

Designation	Av. absorption per cent of dry wt.	Dye test
B.	0.14	Non-Porous
F.	5.17	Very non-porous
BS.	——	Very Porous
BF.	1.08	Slightly Porous

Conclusion.—The substitution of the plastic No. 1 Fine Clay, for the short No. 1 Sandy Clay in a mixture containing no grog gives a weaker body in the dry state but a much stronger body in the fired state.

Description of the Grog Used

The grog used consisted of broken saggers crushed in a dry pan and screened to various sizes by a rotary screen. Three sizes of grog were chosen for this experiment because each size was available in large quantities and represented roughly course, medium, and fine mixtures of grog. The screen analysis of each grade of grog was approximately as follows:

[1] L. E. Barringer, "A Continuously Operated Tunnel Kiln for High Grade Clay Ware," *Trans. Amer. Ceram. Soc.*, **18,** 106 (1916).

	Grog No. 1	Grog No. 2	Grog. No. 3
4–6 mesh	55.6%	.....	.....
6–10 mesh	36.4%	82.0%	.....
10–20 mesh	6.2%	14.0%	.....
20M-Finer	1.8%	4.0%	100%
	100%	100%	100%

Tests of Sagger Bodies

Methods of Making, Drying and Firing the Test Pieces.—The materials entering into each body were carefully weighed out, mixed thoroughly while dry, moistened with water and then wedged. Nine test pieces 1 × 1 × 6 inches were pressed from each body. Marks for linear shrinkage measurements were stamped on opposite sides of each bar immediately after it was removed from the mold. The test pieces were dried for thirty hours in a Proctor Humidity Dryer. Three dry test pieces from each body were retained to be tested for dry modulus of rupture. The remaining six pieces from each body were fired in a Didier-March Tunnel Kiln to a temperature of cone $10^1/_2$.

Method of Making Tests.—Three dry unfired pieces of each body were broken to determine its unfired transverse strength. They were broken on a home-made machine by loading the center of each bar over a $4^1/_2$-inch span. The modulus of rupture was calculated from the usual formula.

The transverse strength in the fired state was determined on three of the fired pieces from each body using a span of five inches.

The three remaining fired pieces of each body were used to determine resistance to heat changes. The test pieces were first placed in the preheating chamber of an electric enameling furnace for five minutes at 450°F; then pushed into the hot chamber for seven minutes at 1556°F; then taken out and immediately quenched in water at room temperature. The

Series I

Composition of Bodies

Body Number	1	2	3	4	5	6	7	8
No. 8 Buff Clay	36%	36%	36%	29.8%	29.8%	29.8%	29.8%	27.0%
No. 1 Sandy Clay	22	..	..	....	....	....	....	....
No. 1 Fine Clay	..	22	22	18.2	18.2	18.2	18.2	27.0
No. 1 grog	42	42	..	42	..	..	..	36.0
No. 2 grog	..	..	42	..	42	42	42	..
No. 3 grog	..	..	..	10	10	5	5	10
White Talc[1]	..	..	..	..	..	5	..	..
Asbestos[1]	..	..	..	..	..	..	5	..
	100%	100%	100%	100%	100%	100%	100%	100%

[1] Magnesia Talc Co., Waterbury, Vermont.

number recorded is the times the piece stood this treatment before it became so weak that it could easily be broken between the hands. The results, with a few exceptions, were remarkably uniform considering the nature of the tests.

The use of talc and asbestos has been suggested by others.[1]

Results of Tests

Body no.	Av. linear shrink. per cent of wet length			Modulus of rupture lbs. per sq. in.		Resistance to heat changes, no. of heats withstood.		
	Drying	Burning	Total	Dry	Fired	Min.	Max.	Aver.
1	3.0	1.5	4.5	39.0	520	..	..	11.3
2	5.0	3.7	8.7	18.0	745	..	..	9.5
3	4.0	4.0	8.0	20.0	785	..	..	10.3
4	4.5	3.5	8.0	40.6	860	12	13	12.5
5	4.0	3.0	7.0	43.9	960	13	17	15.0
6	5.0	4.0	9.0	64.0	1360	3	Over 18	Over 10.0[1]
7	5.0	4.5	9.5	84.5	1280	13	Over 18	Over 15.0
8	5.5	3.5	9.0	41.1	1230	7	8	7.6

[1] One bar broke at three heats, one at ten heats, and one did not break in eighteen heats.

Comment on Results.—1. A comparison of Bodies No. 1 and No. 2 shows that the substitution of the plastic No. 1 Fine Clay for the No. 1 White Sandy Clay increases the shrinkage, decreases the dry transverse strength and increases the fired transverse strength. This agrees with the results on the same mixtures of clay but without grog. Body No. 1 containing the sandy clay shows better resistance to heat shocks.

2. A comparison of Bodies No. 2 and No. 3, also Bodies No. 4 and No. 5 shows that the substitution of the medium grog (No. 2) for the coarse grog (No. 1) increases the dry transverse strength, the fired transverse strength, and the resistance to heat changes.

A comparison of Bodies No. 2 and No. 4, also No. 3 and No. 5 shows that replacement of 10% of clay by 10% of fine grog (No. 3) doubles the dry transverse strength, increases the fired transverse strength and increases the resistance to heat changes.

3. A comparison of Body No. 6 with Body No. 5 shows that replacement of 5% of fine grog (No. 3) with 5% of talc increases the shrinkage, and increases the dry and fired transverse strength approximately 50%. With the exception of one very low result the test pieces containing 5% of talc also show high resistance to heat changes.

A comparison of Body No. 7 with Body No. 5 shows that the replacement of 5% of fine grog (No. 3) with 5% of asbestos increases shrinkage, increases dry transverse strength 50%, increases fired transverse strength about $33^1/_3$%, and slightly increases resistance to heat changes.

[1] George Simcoe, "Importance of the Sagger Making Department," *Trans. Amer. Ceram. Soc.*, **17,** 256 (1915); "Saggers! Past, Present, Future, their Scientific, Humanitarian and Commercial Aspects," *Trans. Eng. Ceram. Soc.*, **14,** 27 (1914–15).

4. A comparison of Bodies No .4 and No. 8 shows that a 6% increase in total percentage of clay at expense of coarse grog (No. 1) combined with an 8.8% increase of No. 1. Fine clay has the effect of increasing fired transverse strength about 50% but reduces resistance to heat changes over 33⅓%.

Conclusions.—Of the bodies tested in Series I Bodies 1, 4, 5, 6, and 7 seem to warrant further laboratory tests and trials under plant conditions.

No. 6 and No. 7 bodies look promising. The chief question would be whether or not they would hold up the required load at a given temperature without sagging.

Series II[1]

Compositions of Bodies

Body Number	1	9	10	5	11
No. 8 Buff Clay	36%	36%	36%	29.8%	28%
No. 1 Fine Clay	..	11%	..	18.2%	28%
No. 1 White Sandy Clay	22%	11%	..	...	..
Raw Flint Fire Clay (Harbison-Walker)	..	..	22%	...	..
No. 1 grog (Coarse)	42%	42%	42%	...	36%
No. 2 grog (Medium)	..	..	..	42.0	..
No. 3 grog (Fine)	..	..	..	10.0	8
	100%	100%	100%	100%	100%

Results of Tests

Body no.	Av. linear shrink. per cent of wet length			Av. modulus of rupture lb. per sq. in.		Resistance to heat changes no. of heats withstood		
	Drying	Firing	Total	Dry	Fired	Min.	Max.	Av.
1	3.6	2.9	6.5	34	830	14	18	16.0
9	4.1	4.1	8.2	29	1050	4	14	10.0
10	2.7	7.0	9.7	32	810	5	14	10.7
5	4.4	3.5	7.9	35	1120	12	19	15.7
11	5.3	2.4	7.7	41	1110	13	17	15.0

Comment on Results.—1. The results of the tests on the fired pieces run somewhat higher than one would expect from the results of Series I. This is particularly true of Body No. 1. It may be partially accounted for by the fact that the sandy clay used in this series came from a later car and seemed to be of a somewhat more clayey nature than that used in the first series.

2. A comparison of the results of tests on Bodies No. 1 and No. 9 tends to confirm the conclusion that the substitution of No. 1 Fine Clay

[1] This series consisted of two of the best bodies from Series I and several other bodies of a similar nature. The forming, drying, firing and testing were performed exactly similarly to that for Series I.

for No. 1 White Sandy Clay increases the shrinkage, decreases the dry transverse strength, increases the fired transverse strength and decreases resistance heat changes.

3 A comparison of Bodies No. 1 and No. 10 shows that the substitution of raw flint fire clay for the No. 1 White Sandy Clay increases the firing shrinkage and reduces the resistance to heat changes. The dry and fired transverse strengths are practically the same in each case.

Conclusions.—From the results of these laboratory tests the bodies rank as follows: No. 5, first: No. 11, a close second; and No. 1, third.

Series III[1]

Sources of Materials:

Georgia Kaolin-Edgar Bros. Co., McIntyre, Ga.
Tenn. Ball Clay No. 5-Mandle Clay Mining Co., St. Louis, Mo.
Kentucky Ball Clay No. 4-Ky. Construction and Improvement Co., Mayfield, Ky.
Flint Fire Clay-Harbison-Walker Refractories Co., Pittsburgh, Pa.
Carborundum Firesand, Carborundum Co., Niagara Falls, N. Y.

Composition of Bodies[2]

Body number	12	13	14
Georgia Kaolin	35%	..	..
Tennessee Ball Clay No. 5	10%	..	..
Kentucky Ball Clay No. 4	..	56%	40%
Raw Flint Fire Clay	..	24%	..
Medium Sized Carborundum Firesand	..	..	60%
Grog[3]			
10–40-mesh	55%	..	..
10–26-mesh	..	15%	..
20-mesh to Dust	..	5%	..
	100%	100%	100%

Results of Tests

Body no.	Av. shrinkage per cent of wet length			Av. modulus of rupture lbs. per sq. in.		Resistance to heat changes no. of heats withstood		
	Drying	Firing	Total	Dry	Fired	Min.	Max.	Av.
12	3.7	2.0	5.7	23	680	All over 25		..
13	5.0	7.7	12.7	120	1830	9	15	12.7
14	4.6	0.6	5.2	110	1730	All over 25		..

[1] This series consists of refractory bodies somewhat different from those usually used. These bodies were made, fired and tested at the same time as those of Series II, but they are reported separately owing to their different nature.

[2] Body No. 12 was suggested by F. H. Riddle, "Porcelain for Pyrometric Purposes," —"Pyrometry," p. 240 (1920), *Am. Inst. of Min. Met. Eng.*; Bodies No. 13 and No. 14 were suggested by two crucible bodies by H. Huisken, Thesis, June, 1920, U. of Ill.

[3] Calcined flint fire-clay grog was recommended in the original formulae. In this series, ordinary sagger grog was used because it could be gotten cheaply and plentifully

Comment on Results.—The results of the tests on Bodies No. 12 and No. 14 indicate that they are much superior to any body previously tested. Their chief drawback for plant use is the high cost of their materials. No. 12 seems to be very promising as a basis for future work on sagger bodies containing high grade clays. Modifications of it and No. 14 might prove successful enough to warrant the additional cost.

Plant Trials

From the results of the laboratory tests, No. 5 was picked as being the best of the fire clay-grog bodies. Under the direction of Mr. L. E. MacFadyen, 100 saggers were made from this body for trial under plant conditions. These saggers were formed in a hydraulic press after the body had been tempered in a wet pan and pugged through a horizontal mill.

Four slightly different methods were used in the making of the unfired saggers: 50 saggers were made using dry grog: 50 saggers were made using water-soaked grog: half of each set of 50 was dried rapidly in a steam drier, while the other half was dried more slowly in the open air on top of the steam drier. These different treatments did not seem to be a material factor in the results. All of the saggers were flawless after drying. For their first fire the green saggers were placed in a round periodic kiln in five bungs, each bung twenty saggers high. After the first fire the saggers were fired carrying the regular load of ware. Records were kept only as far as the fifth fire.

Results:[1] (about cone 10½)					
No. of fires	1	2	3	4	5
No. of broken saggers	1	2	2	3	3
No. of slightly cracked	4	13	14	14	15
No. of missing saggers	0	10	9	15	19
No. flawless saggers	95	75	75	68	63
	100	100	100	100	100

General Conclusions

Body No. 5 proved to be better than the regular sagger mix both in plant and laboratory tests. This accomplished the primary object of these experiments by the development of a good sagger body from relatively cheap fire clay-grog materials.

[1] Abstracted from Mr. MacFadyen's report. This makes a very good showing for this type of sagger. The saggers which were listed as being slightly cracked were still strong enough to be used for ware. The saggers listed as missing were misplaced by workmen. Most of these missing saggers turned up later. In practically every case they were in good condition when found. Accurate plant service records of any of the other bodies cannot be given. Body No. 1 stood up rather poorly in use. An estimate was made that it averaged 5 times through the kiln before breaking. A few saggers made from a body similar to No. 14 were still good after 20 trips through the tunnel kiln.

Incidently Bodies No. 12 and No. 14 made from somewhat more expensive materials were superior in the laboratory tests to any of the cheaper bodies. These laboratory results were partially confirmed by plant tests.

The chief objection to sagger bodies of types similar to No. 12 or No. 14 would be their high initial cost. This very common basis of comparing the costs of sagger mixes is obviously wrong. The relative cost of a sagger body should be based on the average cost per fire, which would also take into consideration the lives of the saggers. Positive data for such a comparison can be obtained only through actual plant trials of a large number of saggers from each mix, keeping accurate records of their first cost and firing behavior. On this basis of comparison saggers made from expensive materials might in the end prove less costly than those made from cheaper materials.

HIGHLAND PARK, MICH.

EXPERIENCES WITH DUTCH KILNS

By Roy A. Horning

Description

The Dutch kiln is about the simplest form of kiln. For the benefit of those not familiar with this kiln a brief description may be worth while.

Essentially a Dutch kiln has only four permanent walls, no crown, and it may or may not have fire boxes. Usually a Dutch kiln will have grates extending all the way through the kiln or they may extend into the kiln only a short distance. The newer kilns have grates running all the way through and have large ash pits. On each side of the kiln are firing holes, the number of which depends entirely upon how many arches are to be set. Roughly there is one arch to each 20,000 bricks. The capacity of the kiln depends on how many arches it can accommodate. They may run as low as five arches or they may run as high as twenty-four arches. Usually a roof (either fire proof, or removable wooden) is placed well above the kiln, merely as a protection against the weather.

Some plants deem it wise to enclose the kilns completely within a building. This is not necessary and only under very extraordinary conditions is this desirable. The kilns, under the supervision of the writer, have an improvement that means a great deal to the burner. Thirty inches from the top of the walls a three foot walk is placed and attached to the kiln by steel brackets. This walk enables the burner to get around the top of the kiln with ease and safety and it also gives him a chance to put coal along the head walls during the burn. This feature will be described a little later.

Setting

There are as many different ways of setting brick in Dutch kilns as there are owners of them. Each man has some little thing that he does differently from the others. Essentially they are set the same. First of all there are the arches. These may be set high or low, depending on the nature of the clay and the width of the space between the arches. We close up with four overhangers with eight courses below them. It is possible to set brick fifty or fifty-five high depending on the nature of the clay and also somewhat on the coal.

After the kiln has been filled it is covered with a flat course of brick known as platten.

Burning

Preparation for Burning.—After the kiln has been filled the entire top of the kiln is covered with a layer of buckwheat coal; about forty pounds

to the thousand. This is scraped into the top course with no attempt to work it down into the setting. The platten is then placed on this, leaving every other pair standing on end. The casings are run up and given a good thick coat of daubing. The arches are filled with fire wood and about six tons of egg or broken coal are equally distributed through the arches.

This wood and egg coal gives a good dry heat for about twelve hours. This enables the steam to start from the brick and gets the draft started without the danger of sooting up the setting. This fire is followed with low volatile bituminous firing with the ash and fire doors wide open to give the kiln plenty of air. The heat is kept moving as fast as possible, watching carefully that the arches do not get too hot. After about twenty-four hours the kiln doors are partially shut and from then on the movement of the fire governs how wide each door is to be kept open. It is by this means that the fire is driven from one place to another in the kiln. At the end of forty-eight hours we aim to have the fire through the top of the kiln. As fast as the fire works out we put the platten down. When the fire is up uniformly over the kiln we start to settle, and when the middle has settled about two inches we coal the heads.

In coaling the heads the burner goes up on this platform and by means of a special shovel he lifts the platten three at a time two courses in from the head. The helper then throws a bucket of buckwheat coal into this opening and works it down with a rod. The kiln is then ready to settle. The settling is done in the next twenty-four hours and is carried on uniformly until there is thirteen and one half inches. In kilns having twelve arches and holding about 250,000 brick the whole burning process is carried out in seventy-two hours.

This length of time will perhaps sound a bit small but it is done with surprising regularity and sometimes we finish one in less than this time. The chief advantage of the coal put in on top is that when the fire is about half way up there is enough heat to ignite a part of the coal that has worked itself down into the setting. As soon as this coal is ignited the fire immediately runs through to the top. This saves the time which would be required if the heat was generated only in the arches. We aim to put in sufficient coal to burn the top courses. This also saves time as it would otherwise require much longer to force all the heat from the bottom to the top. Another feature is a higher percentage of hards. We often have kilns that run a uniform color to the top course, all being hard.

We have burned brick at this plant for three years and have four distinct kinds of clay that we burn from time to time yet all of them can be handled in about the same length of time. Of course, there are some variations in the way the different clays are fired.

Statistics on Burns

In three years operation
Average time of burn 71 hours,
Average percentage of hards 90.5%
Average kiln loss Culls .5%
Average coal consumption 315 lbs. per M
This coal consumption includes all coal: egg, buckwheat and bituminous.

There are some objections to this method of burning in that you get a distribution of ashes among the burned product, this is objectionable only to the men and then only in a strong wind. We have never had a complaint from a customer about it.

LANCASTER, PA.

CONSTRUCTION FEATURES OF IMPORTANCE TO CLAY PLANTS

By T. W. Garve[1]

ABSTRACT

The paper discusses and illustrates constructional problems in clay working factories namely: Construction work during winter; Laying-out; Earthwork; Road and Railroad; Formwork, Concrete, and Machinery setting; Kilns and Stacks.

Considerations prior to the work, etc., are found under heading: General Recommendations.

Introduction

A brick plant is seldom complete in the first instance. It is at all times subject to developments. There is, as a rule, no definite unit. The builders start with a definite proposal as to capacity but the several processes do not work out as expected: they are not in balance. The balancing work begins and seems never to end. Whatever the explanation, construction work is an annual feature in most clay working plants, and it is the purpose of this paper to discuss such constructional problems.

General Recommendations

The first step in any improvement should be plans and specifications. Too many clayworkers plan improvements by looking over the situation, and proceeding without further consideration, only to find later that they have made a number of blunders which would not have occurred if the project had been worked out on paper and fully considered before starting the work. The blunders may temporarily be overcome, but hardly corrected, by some makeshift which will be a continual source of annoyance and expense.

A careful estimate of the cost of the improvements should be made and covered by an appropriation.

Each clayworker should have a plan of his plant, in tracing, from which blue prints can be taken and used for study and submission to engineers, machinery concerns, and others for advice in every proposed improvement. These should show not only property and buildings to scale but also all machinery with shafting and drives and all the equipment together with notes on sizes and make. Also building posts or columns should be indicated and all wiring, piping, and drainage. The size of all piping and drains should be marked and also all valves and intakes. Such a drawing should be kept up to date. Such a print is the best record available for checking up the equipment, for locating leaks or stops, and for getting necessary and accurate distances and clearances.

It is advisable to do construction work, if at all possible, during times of depression. It will insure lower material and labor costs, and will receive closer attention and more prompt shipments of materials, and will cause less interference with regular production.

[1] Recd. May 15, 1923.

For a new plant or large extension, it would be advisable to have a construction engineer who will work in harmony with the management and the construction foremen but who will have vision and nerve enough to go ahead on his own responsibility. The construction engineer should be careful yet firm and quick in his decisions and actions. He must be an inspiration to the men. He should demand work for pay without being a driver.

On large jobs, it is desirable to use time slips of a special color and especially designed. They should be handed to the construction engineer every night who then can make his entries before delivering them to the time keeper. Different sections of the work such as different buildings or different classes of work like excavating, concreting, carpentry, bricklaying, etc., should have special numbers marked on the time slips. This will enable the engineer to see whether each job is progressing within the estimated cost. It is important that the engineer in charge should be feeling the pulse of the work at all times, and for this the time slips are excellent.

The tool, office and lunch shanties for the construction gang can be portable or collapsible buildings, the roof, floor, and four sides of which are complete and separate units, bolted together or simply hooked together. It will permit of easier transportation of the buildings around the works saving time and labor, and the salvage will be greater at the end of the job.

The tractor is a most helpful and useful contrivance for almost any kind of construction work. We have successfully done rooting, plowing and scooping with a tractor and two Maney scrapers; have driven the saw mill, the cross cut saw, the machinery of the plant; have hoisted building timber, steel, and other material; tilted up concrete chuting tower; pulled up complete roof trusses; unloaded and moved heavy machinery and equipment; moved railroad cars, shanties, logs, etc.

Another modern contrivance is a Ford truck with a flat bottom that can be tilted by its own power. It can be used for excavating or filling purposes, for hauling and placing sand, gravel, stone, coal, or else it can also be used for hauling the men to and from work. Of course, it will not entirely replace teams.

There should be a winch, two sets of blocks with tackles and snatch blocks, and pipe or wooden rollers. Good hemp rope in various lengths should be kept indoors whenever not in use.

Be sure that shipments are made in proper time to keep the work going at its maximum. This applies to machinery as well as to building materials.

It is important, in order to avoid second handling and confusion, to place every shipment in its proper place to prevent again being moved.

A railroad car will hold as an average about 200 barrels cement, equal to 800 bags, 16,000 board measure of heavy timber and 20,000 board measure of light timber, 16 cords of wood, 45 cubic yards of sand plus gravel, etc.

Construction work should be protected against fire and accidents. Such safe-guards have to be changed continually.

Construction Work during Winter

Most construction work on heavy clay product plants in the northern and middle states is done during the winter when orders are not rushing. There are many points in its favor especially if the season happens to be an open one. It is important that all brick and concrete work be protected from frost until the mortar and concrete are so dry and hardened that no water is left to freeze.

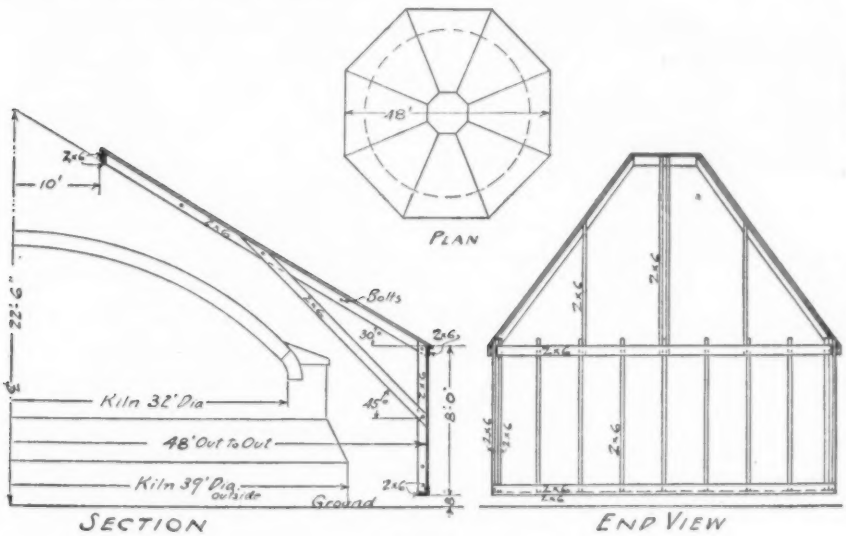


FIG. 1.

To effectively accomplish this often requires a lot of time, labor, and extra expense. Use of hot water and heating of the sand will help some but they will cool rapidly after being placed; salamanders and coal stoves may be set up so the wind will drive the heat and smoke towards the work. The direction of the wind might change suddenly over night and the cold continue long enough to do a lot of damage if proper care has not been taken.

Empty cement bags, boards, roofing-paper, straw and manure can be laid over the concrete. A concreted trench can be protected by covering the top, and then placing oil lamps inside of it. It is advisable to purchase several large tarpaulins before commencing winter work. They can also be used to great advantage for protection of men, machinery and equipment against rain (See Fig. 8).

Winters with continually changing temperatures from below to above freezing are apt to do more damage than cold steady winters.

Brick or concrete stacks should not be built during winter. It is advisable to have all the outside walls and crown of kilns done before the cold weather sets in, and then build the kiln bottoms and bag walls during winter with salamanders for protection. If no coke can be had for salamanders, it is better to use coal stoves.

When constructing a number of round kilns during winter, we have found it advisable and profitable to erect a construction shed, as seen in Figs. 1 and 2. It is octagon in shape and the sections are bolted together. The cost is about $600.00. A number of uses can subsequently be found for storage, garage, etc.

FIG. 2.

All brick used for construction during winter should be stored under roof.

Avoid use of frozen sand or gravel for leveling or tamping under railroad ties or for other use. It will yield after thawing and throw the work out of line or level. Keep frost balls out of the mixer.

All the pipe lines should either be properly protected (underground in sawdust) or be drained every night. All valves should have drip cocks. One man should be responsible for the pipe lines, attending to them every night and inspecting them the first thing every morning. All the piping, which is apt to freeze, should be painted red.

Laying-Out

We consider it essential that the construction engineer shall be familiar with the operating of the plant under construction whether it be the plant kiln or drier. A drawing might not be fully clear or dimensions not checked or errors not detected that will require quick decision and remedy. We have seen the most artistic picture drawings which were practically worthless to the construction engineer. He had to develop speedily his own sketches.

There should be a transit, and also a small level. There are special builder's levels which have a tilting telescope. They are light and easily handled but not as sensitive nor as accurate as transits. We prefer a transit for plant layout.

No stakes should be placed at corners of buildings nor at centers of posts for in excavating they will have to be removed. Corner stakes, set a few feet outside (Fig. 3) can remain undisturbed and the work checked at any time. It is essential to establish a grade line high enough so that

the bottom of the deepest pit will be above the high water mark of the underground water.

Earth Work

Steam shoveling is the only and proper method for deep cuts of over four feet and for hard material. It costs between 30 and 50 cents per cubic yard. Contract should be let on cubic yard basis.

For soft ground, like loam, top soil, gravel, or sand, less than four feet in depth, and not to be hauled distances exceeding one hundred feet, scoops and teams will give the best results, costing around 50 cents per cubic yard.

Scoop work can often advantageously be done in connection with steam shovel work for trimming off the edges or for some special excavation of minor depth. Scoops can also be used on large machinery foundations.

The capacity of a scoop, dragged by two horses, is one quarter cubic yard. Most often the ground requires some plowing before scoops can be used. This can be done by teams but often most advantageously by tractor.

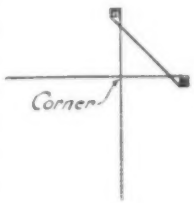


FIG. 3.

For small machinery foundations and trenches for building walls, the pick and shovel method is the only one, though it may figure per cubic yard three times as much as the scoop method, costing anywhere from $1.00 to $2.00 per cubic yard.

The large Maney scrapers of a rated capacity of one cubic yard can be used to advantage with a tractor. We have used one and even two on one tractor.

Whenever possible, any kind of earth work should fulfill the double purpose of a necessary cut in one place and an essential fill in another place.

Road and Railroad

Burned waste material, also ashes with cinders are available and they should be used unsparingly for road building and upkeeping.

The vehicle road connection should be given as much study as the railroad switch.

Steep roads, even for short distances, should be avoided, keeping below 3 per cent grade.

For railroad switch, figure about one and a half foot from top of rail to the ground, whether cut or fill, for the rail, the tie, and the ballast. After the ground is fairly level, place the ties on the ground about two feet apart, actually 16 ties for each 33 feet rail length. Then roll the rails on top of the ties, breaking joints, and bolt with fish plates each line of rail. Then locate one rail line in reference to the ties by measuring with a 21-inch stick from outside web of rail to end of each tie, and then drive the spikes, two in each tie diagonally opposite each other.

The other line of rail is spiked after using the gage from the first line. Special tie plates should be used at switches and also at curves between top of tie and bottom of rail. Dump the ballast (cinders or gravel) over the track, and raise the track by railroad jacks to level marked by stakes

Curve	a	b	c	d
12°	3°	6°	9°	12°
16°	4°	8°	12°	16°

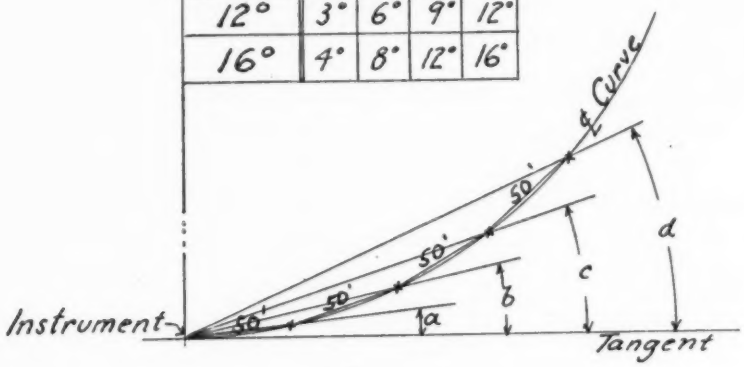


FIG. 4.

and work the ballast underneath tightly with tamping picks for about two feet under the rail but not all along the tie. This should be done roughly all along the line. Later go over again in the same way for finer adjustments which can be well judged by the eye.

For curves, no rail benders are required. The line is simply bent or forced over with crow bars after the rails have been bolted together firmly.

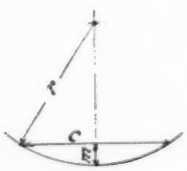


FIG. 5.

Degree of curve	Radius of center line of curve	Radius inner rail inside r	For cord $c = 50'$ Middle ordinate $m =$	For cord $c = 62'\text{-}4''$ Middle ordinate $m =$
12°	478.34	447.59	8″	12″
14°	410.28	379.53	10″	14″
16°	359.26	328.51	12″	16″

The curve can be laid out with a transit using iron pins every fifty feet in the center of the track, as shown in Fig. 4. The railroad companies usually do not permit of a curve more than 12 degrees but 16-degree curves are built for light equipment.

No railroad grade should exceed $1^1/_2$ per cent.

Ninety pound rails should be used and not lighter than eighty pound rails for factory switches. The outer rail of a curve should be between

2 and 4 inches higher than the inner rail to prevent the flange from crawling up the outer rail.

A simple way of ascertaining the degree of a curve is by holding a tape against the inner rail and measuring the middle ordinate. We have figured it out for a 50-foot cord, though the customary method is to use a cord or tape length of 62 ft. 4 in. where the middle ordinate is numerically equal to the degree of the curve (see Fig. 5).

In calculating a railroad bank or fill, it should be borne in mind that the angle of repose is to be taken as $1^1/_2$ to 1, which will make the bottom of a high bank or the top of a deep cut extremely wide. The top of a railroad bank should not be less than 12 ft. and better not less than 14 ft. wide, the ties being 8 ft. 6 in. long.

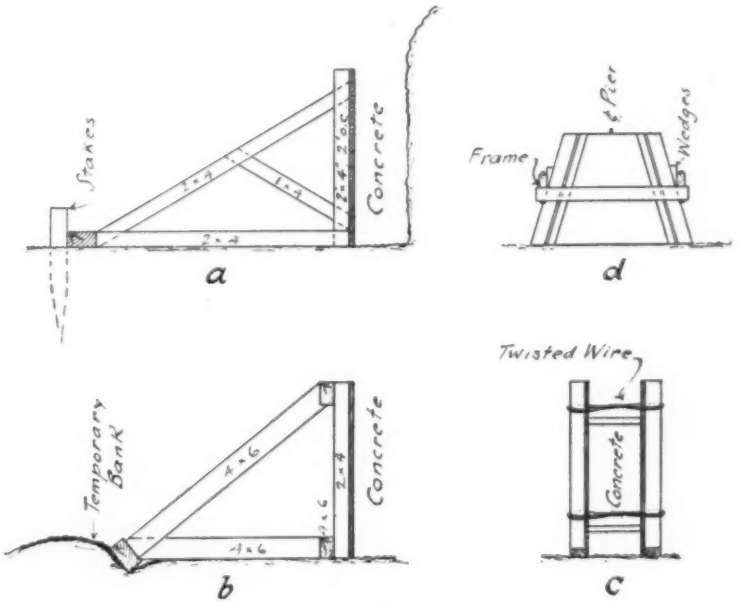


FIG. 6.

Good ties can be made out of oak or chestnut. Impregnated ties are being used to advantage.

It is best to have frog and switch work done by the railroad section crews, while the ordinary track and curves can be done cheaper by the builder.

Form Work, Concrete and Machinery Settings

Tongued and grooved sheathing, 6 in. by $^3/_4$ in. are frequently used for form work. These latter may be used for roofing, siding or partitions. Tongued and grooved sheathing should not be used where the forms,

after stripping, have to be re-cut to be used over again. The cement gets into the grooves and the boards will have to be cleaned and scraped.

The studding should not be less than 2 ft. apart for $^3/_4$ in. boards, while with 2 in. boards the studding can be spaced wider. The studding can be of hard wood while the boards should be soft wood to be easily sawed and nailed. Only two nails should be used at the end of each board. It is the studding that gives strength to the form.

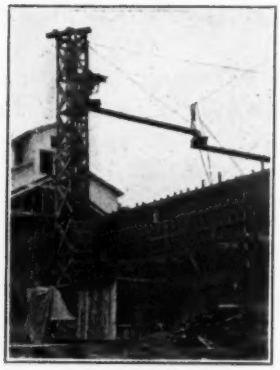


FIG. 7.

For good form work, to be used again, we would recommend 8 in., 10 in. or 12 in. wide boards, dressed, and either $^3/_4$ in. or $1^3/_4$ in. according to the size and purpose of form, made of common white pine, yellow pine, spruce, or hemlock. Wide boards save time in handling, in nailing, and in sawing. For studding, 2 in. by 4 in. lumber is customary.

The bracing of the form is most important. If at all possible, the bracing should be carried against a fixed and solid object, like a wall or a foundation. The forms can be braced, as shown in Figs. 6 *a* and *b*. Two parallel forms of a straight wall are best held together by soft steel No. 13 gage wire looped around the studding and then twisted tight as illustrated in Fig. 6 *c*. A pier can be braced by a wedge frame as shown in Fig. 6 *d*.

Edges and corners of exposed concrete work are easily damaged. Outside corners should be beveled and it is desirable to have a fillet in all inside corners.

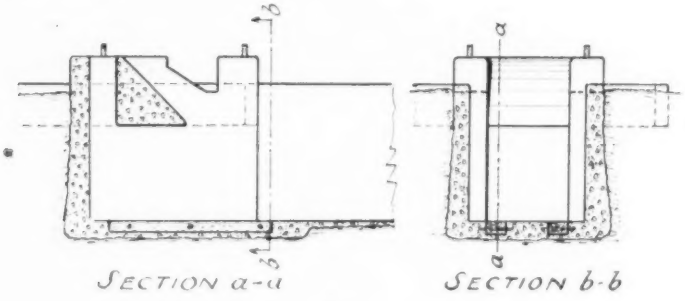


FIG. 8.

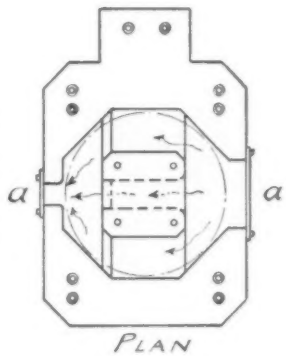
The mixture ordinarily used for plain concrete is 2–3–5 (gravel-sand-cement) and for reinforced concrete 1–2–4. Proportioning by shovel is accurate enough. If sand and gravel are obtained mixed, more cement must be used.

On an extensive concrete job it often pays to set up a concrete chuting tower which should be high enough that every corner of all forms can be reached from the end of the chute. The material will slide at an angle of about 25 degrees over the first chute which receives the material at a certain momentum from the hopper while the lower chutes should have an angle of about 30 degrees. Use of water to make the concrete slide the chutes is detrimental to the strength of the wall. Fig. 7 shows bracing and use of chuting tower in construction of reinforced concrete clay storage. This tower was later used for the kiln and kiln building foundations.

On small jobs, it is advisable to move the mixer rather than to lengthen the wheelbarrow hauls.

If the forms are taken off the second or third day, the wall surface may be finished with a wire brush and the corners beveled. Care must be used in stripping the forms too soon since the concrete can easily be damaged.

Fig. 8 is the foundation of a single roll crusher. It provides a concrete hopper and sufficient depth for the conveyor or elevator. The pit is large so as to give easy access to the lower part of crusher and conveyor. The pit is also provided with sleepers, embedded in concrete for holding the tail ends of conveyor or elevator. On each side of the main walls is a shallow pit for the gear on one side and the pulley on the other side, but wide enough to allow sliding them out over the shaft. The anchor bolts are shown solid in concrete.



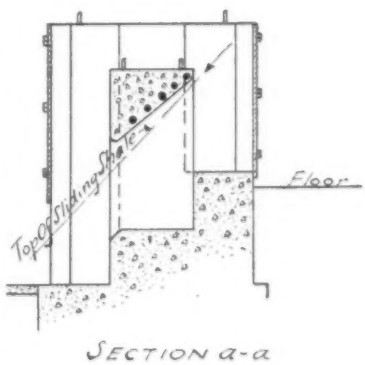


FIG. 9.

Fig. 9 shows a pan foundation for a gravity bottom which permits of easy access to the step box. There is an opening through the step box foundation, its top being reinforced. This gives a solid foundation for the step box yet gives almost the same free passage to the material as the steel beam supports. The anchor bolts are to be placed within large pipes fully to the bottom since pan foundation bolts rarely fit just right, the pan being made up of several castings bolted together.

In Fig. 10 is a cross-section through a foundation for an auger machine with its adjacent pit for waste clay conveyor or elevator. The excavation

next to the pit is carried down fairly plumb to act as form for the machine foundation, and is removed afterwards for the pit.

In Fig. 11 we have a double motor setting for two pans in three different designs. Design "A" was submitted first but rejected since the earth inside the form could not be kept in shape and it would also shrink away later. Design "B" treated the foundation as a bridge or a culvert with open passages and a reinforced slab on top. Design "C" was finally adopted. It provides a substantial footing and enough weight to counteract the pull from the two pans. The sketch is shown so the pull from the motors is against the observer, hence the front and rear of design "C" are battered, which the picture does not bring out.

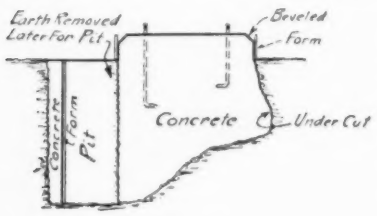


FIG. 10.

Kilns and Stacks

A mason will lay a little more than half the number of brick in a kiln as in an ordinary building. The tendency now is towards the use of more common brick in kiln work where formerly No. 2 fire brick was used. For dipped brick with narrow joints, it is essential to select brick of uniform thickness, and it is also important to lay full mortar joints. There is a vast difference in the purpose and treatment of a dwelling and a kiln after completion, and masons, not experienced in kiln work, should be closely watched. The best plan is to build kilns with alternate header and stretcher courses, and not more than two stretcher to one header course should be used.

Drainage is usually necessary and should be covered by specifications. Its extent and necessity depend entirely upon local conditions.

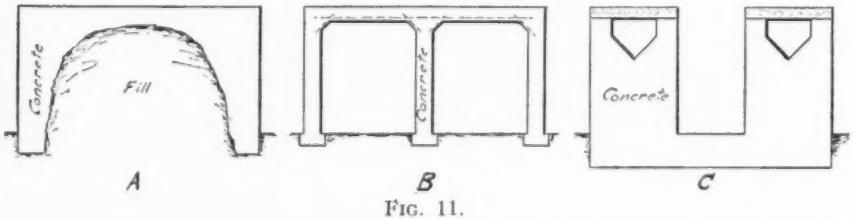


FIG. 11.

Generally speaking, in constructing a kiln, it is best to proceed as follows: Excavate all over to proper depth and lay drains; level up all over with sand; pave all over with one course flat brick; build foundation walls and lower draft flues through foundation; build outside kiln walls complete with furnaces, doors, and crown; build bag wall foundations; build feather walls between bag wall foundations and kiln wall foundation, with proper clearance all around for expansion; lay floor bricks; build furnace bags.

The walls of a round kiln are easily built by means of a sweep, as shown in Fig. 12. The same pole with a different arm, set higher up to correspond with the shape of the crown is being used later as a guide for the circularly set courses of the crown.

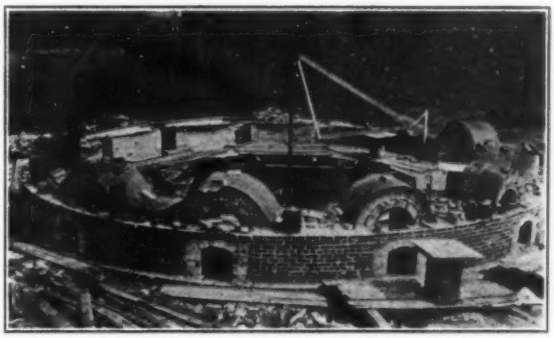


FIG. 12.

The crown of a rectangular kiln or of the chamber of a continuous kiln is erected over a form, consisting of centers and slats, which is set up on bricks or posts and wedged up against the crown to proper level, and is moved along like the smaller forms or centers used on flue arches.

The big band on a round kiln to hold the crown is set up when the wall is high enough to receive the projecting bricks which carry it. The brickwork is set up behind the band but not against it, leaving a layer of mortar for some leeway in expansion.

All brickwork during construction is to be covered over night to prevent rain from washing out the mortar, and to facilitate more uniform hardening and settling over night. Fig. 12 also clearly shows the manner of covering the brick.

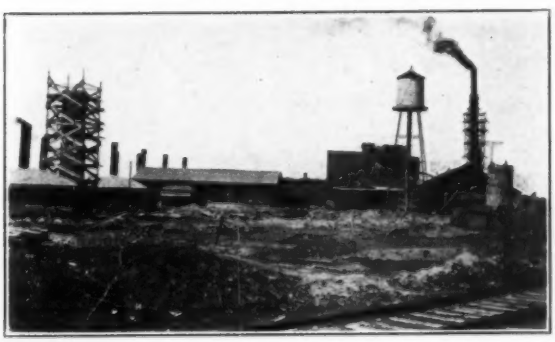


FIG. 13.

Single, double and quadruple stacks with partitions have to be built from the outside by scaffolding while large stacks without partitions for a row of kilns or for power, are erected from the inside. This is very much faster than with scaffolding from the outside. In Fig. 13 is shown to the left a stack with scaffolding and to the right one that is being built from the inside.

The essentials of a good kiln stack are: solid foundation, independent fire-brick lining, outside brick walls in cement mortar with full joints, and a weatherproof coping.

METHOD OF COOLING ENAMEL BY COMPRESSED AIR

By A. Malinovsky

When the enamel industry was in its infancy the molten mass was air cooled by allowing it to run from the melting furnace onto the iron plates. This hard mass of enamel, so produced, took an unusually long time for grinding and caused terrific wear and tear on the mill linings and stones.

As the enamel industry grew demanding larger mill production water cooling was introduced. This gave the molten mass a chill or quench. By this method the enamel is shattered and made brittle, which in turn shortens the milling time and lengthens the life of the mill linings.

Water cooling is economical in milling but otherwise it has its disadvantages. Brittleness and some of the desirable chemical and physical qualities of the molten mixture are changed. The light pieces and all the soluble ingredients of the opacifying agencies are flushed away. The opacifying power of the costly metal oxides is reduced. In the case of powder enamel, the water cooling involves an extra expensive drying process before grinding.

If, as the molten mass is discharged from the spout of the furnace it is subjected to a stream of compressed air the mass will be so shattered that it will grind easily and yet not have suffered loss of properties or of any of its constituents. The molten stream of enamel will be separated into small particles and blown a sufficient distance to become cooled. The molten enamel is separated into very fine flakes or into threads. This is controllable by the air pressure and is influenced by the viscosity of the enamel. Enamel cooled by compressed air is separated and not shattered and therefore will retain its original chemical and physical strength and will hold its elasticity. Numerous tests and experiments with different steel and castings have shown that fish scaling is thus avoided. It also has proven to be more acid proof, does not easily chip, crack, or blister and withstands blows and shocks better in shipping and use.

It eliminates drying before grinding and the enamel will grind in one seventh of the usual milling time thus increasing the output and lengthening the life of the mill.

On account of its fineness and softness, air cooled enamel can be easily milled on the old type stone mill which produces a more workable cover coat enamel than does the usual ball or pebble mill.

This method has been used at Beaver Dam, Wis., for several years with most satisfactory results in every respect and extensive tests were made on a large scale by the Roesch Enamel Range Co. at Belleville, Ill., with steel and cast iron enamels.

Mr. Tomlinson, petrologist, made reports that there is a decided difference in internal textures of air and water cooled enamels. The air cooled enamel shows a uniform clear glass with a faint color whereas the water

cooled enamel shows swarms of minute globular inclusions with a banding arrangement. These globules would form perhaps a tenth of the mass. It appears like thin emulsion of two immiscible substances.

It is very interesting to know that the two samples examined by Dr. Tomlinson were made from the same batch; half of the fused enamel was let into water, and the other half blown by air.

AIR COOLED VS. WATER QUENCHED ENAMELS

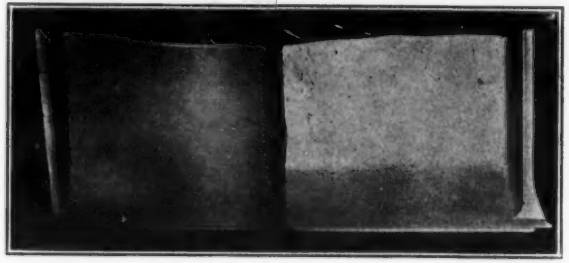
By Stefan Wiester

In 1916, at the Malleable Iron Range Company, Beaver Dam, Wis., I was confronted with the problem of making an enamel that would be more resistant to smoke and flue gases and to shocks in mounting and use.

Fig. 1.

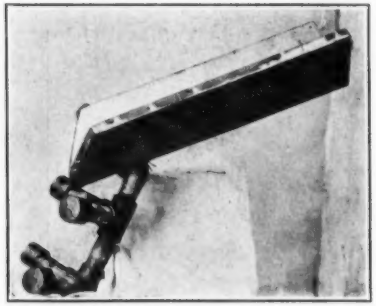
Showing the flow of air-cooled enamel also water tube for water quenching of the tests.

We solved the problem by changing from water to air cooling of the enamel frit. I was anxious to see the wet process work on cast iron so I equipped a small smelter with compressed air containing an enamel used for white

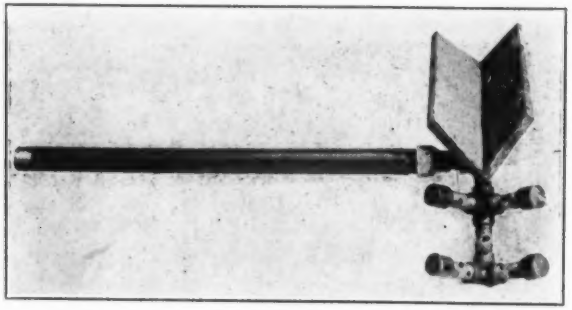


Air cooled. Water cooled.

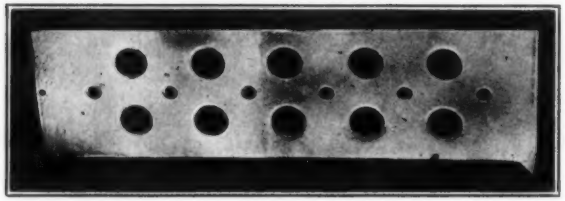
FIG. 2.



SIDE VIEW.
FIG. 2*a*.



FRONT VIEW
FIG. 2*b*.



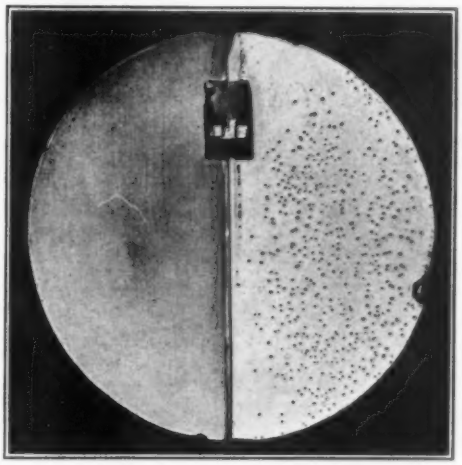
Air-cooled. Water-cooled.

FIG. 3.

cast iron. Boneash, cryolite and antimony were used as opacifiers for the first coat, and 5% tin oxide enamel for the second coat. The raw batch was 150 lbs. It was smelted for 2 hours 30 minutes. One half of the batch was poured into water and the other half was blown and cooled by air. The enamel was pulverized in 25 pound batches to pass a 60-mesh-sieve easily.

The cast iron was cleaned by sand blasting as usual. The enamel was sprayed. One half showed quite a few gas blisters due to underfiring (the time in burning was 10 minutes at 1200°F). The enamel which blistered was poured into water, the other was air cooled.

Two stove lids were taken from the scrap pile, all rusty. They were sand blasted, sprayed, and fired as usual. The air cooled enamel gave a smoother surface with better opacity and more gloss than did the water cooled enamel.



Air-cooled. Water-cooled.

FIG. 4.

To cool enamels by compressed air for dry process a longer spout must be used so as to give the enamel some chill before putting under air pressure. The enamel will then stay in fine threads by regulated air pressure. Otherwise the enamel will get too fine.

The enamel can be blown right into a continuous mill and stored in powdered form, thus saving the handling and drying.

SANDBLAST CASTINGS TO BE ENAMELED

By F. G. Jaeger

Every enameler knows that for successful enameling cast iron must be thoroughly cleaned. This can be accomplished only by sandblasting.

Various types of sandblasting machines are in use for different types of work, but the room type machine is the most advantageous. The tonnage cleaned is determined by the method of handling the work. The hose or nozzle should be kept working as much as possible, as air pressure means horse power and horse power costs money.

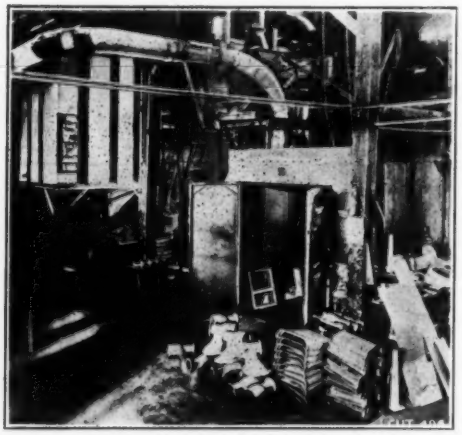


Fig. 1.

The cost per ton varies with the character of the work passing through the sandblast room.

Extensive tests and long experience have shown that the down-draft ventilation of sandblast rooms is most efficient because it prevents the dust from rising to a height where it would inconvenience the operator or obstruct his view of the work.

The sandblast room shown in Fig. 1 has a double ceiling. The top ceiling has ventilators across the full length of the room, spaced on three-foot centers, while the second ceiling twelve inches below the first is composed of six-inch channel sections with a space between each section, making a slotted ceiling. The air is taken through the ventilators in the upper ceiling. The slotted ceiling distributes this air evenly over the entire area of the room.

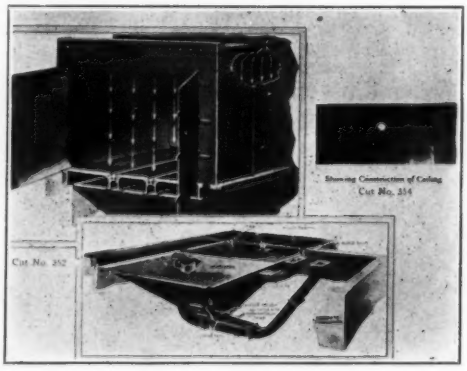


Fig. 2.

The down-draft ventilation has probably done more than any other thing to bring this type of equipment into wide use for sandblasting grey iron castings. While there are many variations on this type, a standard room is one in which one operator may sandblast many tons of castings

in a day. The possibilities are limited only by the size of the room, the industry and skill of the operator and the coöperation he has in handling the work to and from the room.

Fig. 3 shows a sandblast room. A complete installation includes a pressure tank, elevating pipe, sand separator and dust arrester. To save factory space, the dust arrester has been placed outside the building. (The wall has been broken away to show dust arrester in correct position.)

In many cases the work to be sandblasted is placed in the room by hand. Where it is possible a more economical and more speedy method is to use cars. Tracks may be laid from where the work originates into the sandblast room. Other methods such as overhead carrying systems may be utilized.

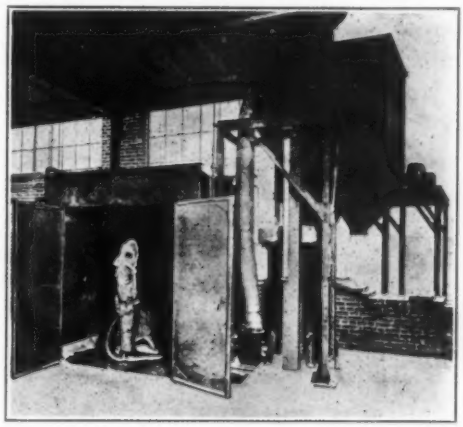


FIG. 3.

This sandblast room is made of twelve gage steel plates for walls and ceilings. The lining plates which protect side walls and doors are 40 inches by 1/4-inch. The room has electric illumination with protective reflectors. The floor consists of wrought iron gratings interchangeable and removable sections resting on the heavy floor beams which also carry the car track. All sand and dust enters the floor hopper through this grating.

The abrasive falls through the floor grating; it is distributed to two inclined screens from which the abrasive and fine material passes to a sand-feeding device at the base of the hopper. Just above the central trough is an agitator consisting of a perforated pipe connected to the pressure tank vent. When the pressure tank is shut off the waste air blows through the perforations in the agitator, and throws the material in the trough back onto the screens for a second screening. The operation of this agitator is automatic and simultaneous with the shutting off of the pressure tank for refilling. It requires no attention. The abrasive and dust is fed from the sand feeding device into the elevating pipe and carried to the sand separator which can be adjusted for single or double separation.

Single operation returns the abrasive to the pressure tank and allows the dust and pulverized abrasive to be carried to the dust arrester. Double separation returns the abrasive to the pressure tank and reclaims the finer sand which is discharged into the pressure tank for re-use. By this method only the dust is carried to the dust arrester.

The arrangement of elevating sand and dust by means of suction created by the ventilating fan eliminates mechanical devices which would be subjected to excessive wear by the abrasive. All elbows of the elevating system and parts lying on a slant are made of $^1/_4$-inch steel plate, easily replaceable.

The volume of ventilating air handled in this manner is based on a velocity in a downward direction of about 70 feet a minute. At this rate the air in the operating room is changed about ten times a minute. As it is drawn downward it carries the dust into the intake pipe in the floor hopper and out to the dust arrester. This keeps the room practically free from dust, takes the terror from the job of the operator and generally conforms with factory laws of the different states. This increases the output, because the operator wastes no time waiting for dust to settle.

The construction below the floor is such that only sufficient air passes through the sand elevating pipe to elevate properly the abrasive. The remainder of the air is utilized in removing the dust through a large dust pipe directly to the dust arrester. This arrangement makes it possible to use abrasives of various specific gravities. This is accomplished by means of a regulating valve in the dust pipe. Both of these air exhausts are taken out of the floor hopper beneath the room above the sand screens so that in case the sand screens should become clogged with gaggers and lumps of core sand, the ventilation of the room would not be impaired. At just about the points at which the air is taken out of the floor hopper there is an abrasive shed which serves the double purpose of distributing the abrasive over the entire area of the screen at the base of the hopper, and of distributing the outgoing air over the entire floor grating of the room. In this way the downward velocity of the air is uniform throughout the room proper.

We have found, after trying other means, that the best results were obtained by working two men in a shift. While one is sandblasting in the room, the other man is loading a truck with castings. A change of positions is made as soon as all the castings in the room have been sandblasted. The doors are thrown and both men unload the room and reload. The castings are piled on the long table and the man who has been on the outside now takes the place of the one who has finished the load just removed from the room. By this method the idle time between room loads is reduced to a minimum.

A fan discharging 6,000 cubic feet of air per minute is located at the opposite side of the room. This air is drawn through the open roof of the sandblast room. This large volume of air in its downward course does not permit the dust from rising more than two feet from the floor thus giving the sandblast operator a clear view of the work and also making for healthful conditions within the room. The operator wears a helmet and gloves for protection from flying sand. Two men have sandblasted

5,000 pounds of light stove plate castings in eight hours and heavier castings can be sandblasted as rapidly as they can be moved by the men. The air compressor supplying air for the work is a 12 × 12 belt driven machine and has a displacement of 345 cubic feet of air per minute and requires about 65-horse power at 120 pounds pressure or about 51-horse power at eighty pounds pressure. Eighty pounds pressure was used on the work described in this paper.

Experience has shown that electricians' rubber gloves stand up better than any other. The flying sand or shot soon wears the threads with which the leather or canvas gloves are sewed and the gloves are then of no further use. The helmet used by the operator is made of canvas and if no protection is given to the seams the helmet is rendered useless in a few days. The entire front and sides of the helmet are covered with rubber sheeting riveted to the helmet. On the sides and in front of the helmet are holes for ventilation. These are covered by a fine wire screen and in the front opening a piece of celluloid just behind the wire screen prevents dust or fine particles from coming through to the operators' face.

The abrasive used is a very hard dry silica sand.

The sandblast operator after closing the doors adjusts his helmet and is now ready for work. He first secures a firm grip on the hose with one hand and with the other turns on the air and sand valves. Pieces too small to hold are strung on a wire, much the same as on a clothes line, along the long side of the room suspended from hooks close to the ceiling.

The flying sand from the blasting of the larger pieces effectively cleans the small pieces which are hung on the wires after remaining there for several hours. Small castings may be placed in a metal tub or barrel and blasted directly with the hose. After a short time the tub is shaken to turn the pieces over and expose new surfaces to be cleaned. As the castings at or near the top are cleaned they are removed so those further down in the tub or barrel may be cleaned.

Cleaning off enamel from defective pieces is accomplished by using the pieces for a sort of back stop by placing them behind the new work being blasted. The sand which has already cleaned the new pieces strikes those from which the enamel is to be removed. Thus the salvaging of castings for re-enameling is accomplished at a very small cost.

The nozzles used have a $^3/_8$-inch opening. A nozzle will last about an hour of continuous use. This should be made of chilled cast iron.

Only the very best rubber lined hose should be used as a cheap hose lasts a very short time.

The wear and upkeep on this type of sand-blasting equipment is very small. Taken as a whole the sandblast room covers a more varied number of uses than any other type of cleaning equipment for this purpose.

SUPERIOR ENAMELING COMPANY,
ST. LOUIS, MO.

THE MECHANICAL STRENGTH OF GLAZING GLASS[1]

By Arthur E. Williams

ABSTRACT

Approximately 5,000 samples of glazing glass of various types have been tested for strength with transverse loading and under impact. Modulus of rupture, modulus of elasticity, impact modulus of rupture, stress strain curve, and actual values required for breaking glass are shown.

The comparative results are shown on 13 different diagrams. These indicate the following values may be used for modulus of rupture for calculating the strength of these various types of glass.

	Modulus of rupture pounds per square inch
Single strength and double strength window glass and 26 oz. clear sheet glass	7,000
29 oz. to 39 oz. clear sheet glass and 1/4" plate glass	6,500
Rolled sheet and wire glass	6,500
Ribbed rolled sheet and wire glass	5,300
Corrugated wire glass 1" deep	13,500
Corrugated wire glass 3/4" deep	9,500
Values for Young's modulus for various types of glass (in pounds per square inch)	
Single and double strength window glass	11,000,000
26 oz. to 39 oz. clear sheet glass	10,500,000
Polished plate glass	10,000,000
Rough rolled glass	970,000
Nonscatterable glass (varies greatly with thickness) 3/16"	16,670,000
7/8"	550,000

Introduction

Information showing the relative strengths of the various types of glazing glass commonly used is rather meager and based on tests of a few samples. A method of testing which can be carried out in a simple manner on small samples of glass is also desirable. The following is a preliminary report of work being done to provide such information, especially with reference to correlating tests on small samples with values obtainable on large sheets of glass mounted in a frame.

Several types of glazing glass are produced and these are made in various thicknesses and by various methods of manufacture. A classification of glazing glass is therefore shown below to indicate the variety of types marketed.

Types of Glass Tested

Approximately 5,000 samples have been tested to provide the results shown in this paper. These samples consisted of various thicknesses of

[1] By permission of the Director of the Bureau of Standards, Department of Commerce. Presented before the Glass Division, Pittsburgh Meeting, February, 1923. For Discussion see *Bull. Amer. Ceram. Soc.*, **2** [8], 294 (1923).

CLASSIFICATION OF GLASS FOR GLAZING PURPOSES

Polished Plate Glass	Second silvering quality	
	Glazing quality	
Clear Sheet or Window Glass	Single strength	A quality
		B quality
	Double strength	A quality
		B quality
	Heavy sheet	Glazing quality
		Factory run
Processed Glass	Chipped	No. 1 Processed
		No. 2 Processed
	Ground	Acid ground
		Sand blasted
Rolled Figured Sheet	Figured sheet	Large variety of patterns
	Colored figured sheet	
Wire Glass	Polished wire	
	Polished (one side)	
	Figured	
	Corrugated	
	Colored	
Ornamental Plate	Figured plate (polished one side)	
Prism Glass	Pressed tile	
	Rolled	

window and clear sheet glass, polished plate glass, processed glass, rolled figured sheet, wire glass and non-scatterable glass. In two cases the samples represented three and five days' consecutive run of two different manufacturers, thus indicating the probable variation in strength likely to appear in a single manufacturer's goods.

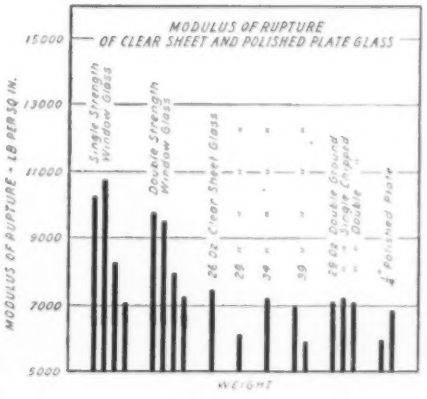


FIG. 1.

Values Determined by Tests

The various factors determined were the actual load required to cause rupture of samples supported on two ends and loaded in the center, the energy required to break samples supported in the same manner when struck a sudden blow and the deflection produced on slow loading. From these values have been calculated the modulus of rupture, Young's modulus of elasticity and an impact modulus of rupture. Stress strain diagrams have been prepared and the elastic properties of the glass up to the breaking point have been determined.

Methods of Testing

Transverse Tests of Small Samples.—Transverse strength was determined on samples 18″ × 2″ using a 16-inch span and loading in the center. The load was applied by shot at a rate of 10 pounds per minute for all window and clear sheet glass and 1/8-inch rolled glass and at a rate of 15 pounds per minute for all heavier glass. Deflection was measured by use of an Ames dial reading to .001 inch placed on the point of application of the load.

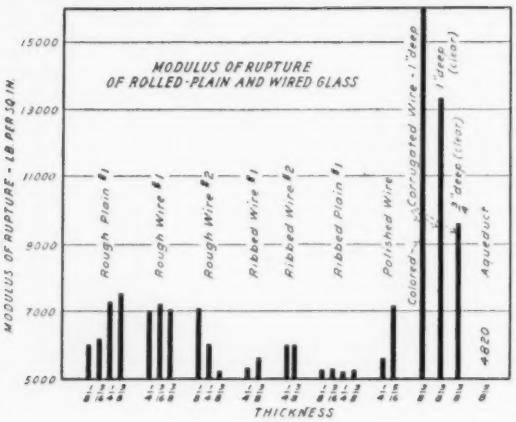


FIG. 2.

The slow rate of loading used was found, as a result of experiments, to be necessary to obtain consistent results, as the actual loads required to produce rupture were never very great.

Impact Tests of Small Samples.—The samples tested were 18 inches long and 2 inches wide, the thickness varying as shown in the charts in which the results are presented. The impact was delivered by means of a pendulum, the tup of which was of hardened steel in the form of a disc 1 1/2 inches in diameter and 9/16 inch thick, with the edge rounded to conform to the surface of a sphere with the same center and diameter as the disc. The weight of the tup was 6 ounces. The specimen, in position for testing, was held with one broad side against two heavy vertical supports of cast iron, so spaced as to provide a 16-inch span. A dial was prepared, graduated in divisions equal to a blow of .025 ft. lb. and in breaking the glass, the pendulum was raised to an angle equal to 0.1 ft. lb. and the tup attached to a magnet held in the proper position.

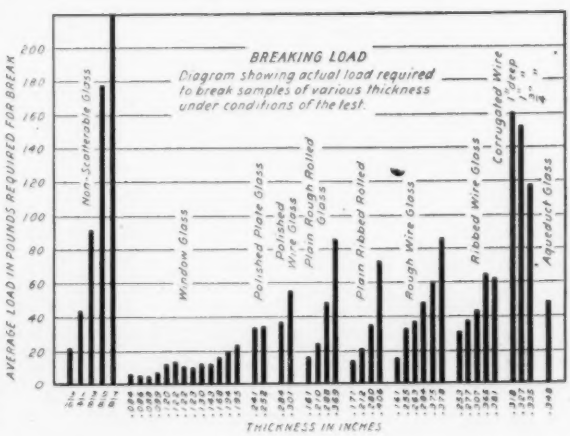


FIG. 3.

TABLE I

DETAILED RESULTS

Factory Number	Style of Glass	Number of Pieces Tested	Average Modulus of Rupture	Average Variation from Mean Modulus	Per Cent Variation from Mean Modulus	Average Modulus of Elasticity	Average Variation from Mean Elasticity	Per Cent Variation from Mean Elasticity	Average Deflection
4	3/16" Nonscatterable	10	8750	928	10.6	1667×10⁴	21×10⁴	1.26	0.13
4	1/4" " "	10	9500	905	9.5	1383×10⁴	55×10⁴	3.96	.13
4	3/8" " "	10	7750	955	12.3	921×10⁴	35×10⁴	3.80	.09
4	5/8" " "	10	5750	447	7.7	790×10⁴	64×10⁴	8.07	.05
4	7/8" " "	9	6520	713	10.9	565×10⁴	33×10⁴	6.55	.05
	Window Glass								
5	A Grade Single Strength	65	10020	1950	15.6	1159×10⁴	70×10⁴	6.00	.42
6	" " " "	74	10770	880	10.2	1159×10⁴	31×10⁴	2.67	.31
7	" " " "	10	8275	460	5.5	1239×10⁴	72×10⁴	5.81	.33
7	B " " "	7	7030	367	5.2	1071×10⁴	48×10⁴	4.48	.28
5	A " Double "	70	9692	1289	14.9	1041×10⁴	46×10⁴	4.50	.29
6	" " " "	76	9442	1167	12.3	1125×10⁴	30×10⁴	2.60	.31
7	" " " "	8	7880	1567	16.1	1200×10⁴	116×10⁴	9.68	.29
7	B " " "	9	7166	2657	33.3	1134×10⁴	19×10⁴	1.68	.26
5	26 Ounce	10	7460	1091	11.8	1069×10⁴	21×10⁴	1.96	.21
5	29 "	10	6111	391	6.4	1053×10⁴	37×10⁴	3.51	.19
5	34 "	10	7230	474	6.5	1045×10⁴	48×10⁴	4.59	.18
5	39 "	10	6980	725	10.3	1053×10⁴	85×10⁴	8.07	.15
6	" "	10	5970	647	11.1	1090×10⁴	37×10⁴	3.39	.12
5	Chipped No. 1	9	7270	481	6.6	1180×10⁴	39×10⁴	3.31	.20
5	" No. 2	8	7130	602	7.6	640×10⁴	30×10⁴	4.69	.28
5	Double Ground 29 oz.	10	7040	380	5.4	1065×10⁴	16×10⁴	1.49	.21
8	1/4" Polished Plate	9	6027	289	4.7	965×10⁴	30×10⁴	3.12	.10
9	" " "	9	6977	675	12.5	1030×10⁴	56×10⁴	5.43	.12
1	1/8" Plain Rough Rolled	23	5875	550	9.3	1050×10⁴	67×10⁴	6.3	.14
		23	6050	503	8.2	1063×10⁴	48×10⁴	4.5	.15
		25	5960	431	7.2	1015×10⁴	64×10⁴	6.3	.15
		24	6070	589	9.7	980×10⁴	48×10⁴	4.9	.15
		23	5920	547	9.2	1030×10⁴	46×10⁴	4.4	.14
	General Average		5975	524	8.7	1027×10⁴	54×10⁴	5.3	.14
1	3/16" Plain Rough Rolled	9	7050	981	13.9	1000×10⁴	29×10⁴	2.9	.13
		25	5500	549	9.9	990×10⁴	63×10⁴	6.3	.11
		24	5840	439	7.5	992×10⁴	43×10⁴	4.6	.12
		24	6240	405	6.4	1009×10⁴	50×10⁴	4.9	.12
		23	6150	429	6.9	991×10⁴	64×10⁴	6.4	.13
	General Average		6156	560	8.9	996×10⁴	49×10⁴	4.9	.12
1	1/4" Plain Rough Rolled	23	8120	1323	16.3	1011×10⁴	49×10⁴	4.8	.12
		25	7725	1312	16.9	995×10⁴	48×10⁴	4.8	.11
		23	6900	763	11.0	1021×10⁴	189×10⁴	10.7	.10
		22	7275	870	11.9	1045×10⁴	57×10⁴	5.4	.11
		21	8625	1303	15.1	983×10⁴	26×10⁴	2.6	.12
	General Average		7729	1114	14.2	1011×10⁴	74×10⁴	7.3	.11
1	3/8" Plain Rough Rolled	14	7120	703	9.7	941×10⁴	44×10⁴	4.6	.08
		24	7120	898	12.6	952×10⁴	56×10⁴	5.8	.09
		24	8210	970	11.8	994×10⁴	60×10⁴	6.0	.09
		25	7610	1218	16.0	972×10⁴	54×10⁴	5.5	.09
		23	7420	1588	21.4	924×10⁴	88×10⁴	9.6	.09
	General Average		7496	1075	14.3	956×10⁴	61×10⁴	6.4	.09

TABLE I

ED RESULTS OF TESTS

Elasticity	Average Deflection	Average Load	Maximum Thickness	Minimum Thickness	Average Thickness	Number of Pieces Tested	Actual Impact	Average Impact for One Inch Thickness	Maximum Thickness	Minimum Thickness	Average Thickness	Impact Modulus of Rupture
6	0.134	22.08	0.185	0.160	0.179	10	0.340	1.87	0.203	0.162	0.1785	1494
6	.130	44.04	.262	.211	.238	10	.457	1.93	.240	.228	.2365	1370
0	.095	92.20	.406	.369	.374	10	.427	1.16	.400	.302	.3740	843
7	.052	177.4	.640	.576	.608	8	.545	0.95	.600	.560	.5539	760
5	.052	419.8	.889	.829	.835	7	1.036	1.11	.920	.795	.8356	628
0	.423	6.4	.100	.065	.084	8	.150	1.78	.097	.086	.095	1148
7	.317	5.0	.093	.083	.086	8	.159	1.88	.087	.083	.085	1236
1	.338	4.9	.093	.071	.088	8	.147	1.67	.097	.076	.087	1213
8	.287	6.9	.116	.090	.099	7	.100	1.01	.091	.083	.086	935
0	.290	10.8	.130	.121	.120	8	.162	1.29	.135	.120	.125	1061
0	.316	12.37	.131	.115	.122	7	.136	1.09	.126	.119	.123	755
8	.297	9.5	.132	.117	.122	6	.154	1.13	.140	.109	.117	1054
8	.269	9.4	.122	.108	.123	8	.194	1.26	.137	.125	.130	1098
6	.213	10.8	.148	.129	.130	8	.169	1.29	.142	.121	.131	985
1	.190	10.8	.150	.138	.143	8	.198	1.38	.152	.141	.143	1022
9	.182	15.2	.173	.163	.168	8	.184	1.14	.170	.160	.162	912
7	.151	22.2	.198	.186	.194	8	.222	1.15	.197	.185	.192	925
9	.127	18.8	.199	.189	.195	7	.186	1.01	.190	.180	.183	886
1	.201	11.4	.149	.131		7	.143	0.99	.152	.143	.145	865
9	.280	5.7	.130	.116		8	.119	0.96	.131	.111	.125	655
9	.211	11.9	.150	.128		8	.169	1.17	.156	.136	.144	904
2	.109	33.0	.260	.247	.241	9	.175	0.68	.260	.247	.255	671
3	.124	33.4	.244	.238	.252	9	.225	1.05	.247	.243	.244	821
3	.143	15.24	.188	.155		24	.113	0.664	.184	.156	.172	696
5	.158	15.80	.180	.156		17	.116	.697	.178	.158	.167	720
3	.151	15.48	.189	.162		24	.111	.630	.188	.165	.177	667
9	.151	15.80	.195	.161		26	.107	.604	.200	.162	.179	642
4	.142	15.48	.189	.163		23	.100	.557	.190	.167	.180	634
3	.149	15.56	.188	.159	.161		.109	.632	.188	.162	.178	667
9	.135	23.40	.222	.177		6	.129	.608	.226	.190	.212	654
3	.117	20.76	.228	.196		24	.112	.698	.236	.207	.219	599
5	.121	22.20	.221	.203		12	.135	.640	.230	.198	.212	666
9	.126	24.60	.229	.202		25	.122	.572	.234	.200	.213	638
4	.136	21.40	.230	.197		25	.135	.637	.227	.198	.212	669
9	.127	22.47	.226	.195	.210		.127	.611	.231	.199	.213	645
3	.121	54.60	.311	.255		15	.330	1.190	.320	.230	.281	914
3	.119	49.40	.328	.232		24	.263	0.938	.306	.238	.270	826
7	.109	42.20	.310	.241		25	.210	.873	.308	.242	.272	745
4	.115	43.80	.322	.243		25	.247	.883	.308	.243	.277	869
5	.127	57.00	.315	.253		25	.212	.698	.327	.264	.305	693
3	.118	49.40	.317	.245	.288		.250	.916	.314	.243	.281	795
3	.088	84.20	.382	.352		23	.313	.825	.389	.355	.374	744
3	.090	80.60	.380	.340		25	.324	.858	.388	.344	.372	764
9	.096	92.60	.385	.349		25	.315	.866	.390	.352	.367	774
5	.090	83.80	.387	.340		25	.281	.771	.389	.340	.366	724
3	.099	82.60	.389	.344		24	.280	.787	.387	.340	.368	705
4	.093	84.76	.385	.345	.369		.302	.821	.389	.346	.369	742

Factory Number	Style of Glass		Number of Pieces Tested	Average Modulus of Rupture	Average Variation from Mean Modulus	Per Cent Variation from Mean Modulus	Average Modulus of Elasticity	Average Variation from Mean Elasticity	Per Cent Variation from Mean Elasticity	Average
1	1/8" Plain Ribbed Rolled		15	5719	499	8.7	1063×10^4	57×10^4	5.3	.14
			25	4923	260	5.2	1040×10^4	32×10^4	3.1	.13
			25	5420	676	10.6	993×10^4	38×10^4	3.8	.14
			24	5040	310	6.1	965×10^4	54×10^4	5.6	.14
			25	5100	264	5.2	1015×10^4	42×10^4	4.1	.13
	General Average			5240	402	7.2	1015×10^4	45×10^4	4.4	.13
1	3/16" Plain Ribbed Rolled		24	5500	525	9.5	997×10^4	60×10^4	6.2	.11
			25	5278	352	6.8	1015×10^4	29×10^4	2.8	.10
			25	5340	314	5.8	1029×10^4	38×10^4	3.7	.10
			24	5330	445	8.3	1025×10^4	54×10^4	5.3	.10
			25	4971	239	4.8	971×10^4	49×10^4	5.0	.10
	General Average			5283	375	7.6	1007×10^4	46×10^4	4.6	.10
1	1/4" Plain Ribbed Rolled		25	5208	502	9.6	978×10^4	85×10^4	8.7	.08
			25	5233	734	12.0	1033×10^4	142×10^4	13.6	.07
			25	5382	725	13.4	979×10^4	132×10^4	13.5	.08
			22	5135	202	3.8	1044×10^4	105×10^4	9.5	.07
			15	4671	272	5.9	964×10^4	87×10^4	9.0	.07
	General Average			5151	487	8.9	999×10^4	110×10^4	10.8	.07
1	3/8" Plain Ribbed Rolled		25	5450	324	5.7	910×10^4	46×10^4	5.0	.06
			25	5500	539	9.8	883×10^4	86×10^4	9.7	.06
			25	5420	406	7.4	843×10^4	37×10^4	4.4	.06
			15	4825	403	8.3	867×10^4	75×10^4	8.6	.06
			20	5260	484	9.2	839×10^4	52×10^4	6.2	.06
	General Average		22	5291	431	8.0	868×10^4	59×10^4	6.7	.06
3	1/4" Polished Wire		10	5569	1148	20.3	1031×10^4	62×10^4	6.0	.09
1	3/16" Polished Wire		25	6909	817	11.8	1031×10^4	62×10^4	6.2	.09
			25	7470	810	10.8	982×10^4	44×10^4	4.4	.10
			24	7130	726	10.1	1025×10^4	34×10^4	3.3	.10
			23	7035	947	13.5	945×10^4	36×10^4	3.8	.10
			25	7087	894	11.0	987×10^4	55×10^4	5.5	.10
	General Average			7126	839	11.4	994×10^4	46×10^4	4.6	.10
2	1/8" Rough Rolled Wire	1	25	7900	844	11.4	1705×10^4	87×10^4	3.1	.12
		2	25	7570	1020	13.5	1596×10^4	149×10^4	9.3	.13
		3	24	5900	548	7.5	1051×10^4	85×10^4	8.1	.12
	General Average		25	7123	804	10.8	1450×10^4	107×10^4	7.5	.13
2	1/4" Rough Rolled Wire	1	23	5640	403	7.1	989×10^4	74×10^4	7.5	.09
		2	24	5850	248	4.0	997×10^4	59×10^4	5.9	.09
		3	24	6260	533	8.6	1003×10^4	64×10^4	6.4	.09
	General Average			5920	395	6.6	996×10^4	66×10^4	6.6	.09
2	1/4" Rough Rolled Wire		81	6430	770	11.9	996×10^4	50×10^4	5.0	.10
1	1/4" Rough Wire		23	6820	880	11.1	985×10^4	38×10^4	3.8	.10
			14	6853	1298	18.9	1028×10^4	78×10^4	7.6	.10
			23	6860	684	9.9	990×10^4	33×10^4	3.3	.10
			24	6950	821	11.8	1025×10^4	48×10^4	4.6	.10
			25	7204	1024	14.2	999×10^4	32×10^4	3.2	.10
	General Average			6937	941	13.2	1005×10^4	45×10^4	4.5	.10
1	3/8" Rough Wire		15	6860	880	12.8	952×10^4	45×10^4	4.7	.08
			23	7040	898	12.7	985×10^4	74×10^4	7.5	.08
			24	7280	673	9.3	956×10^4	81×10^4	8.7	.08
			25	6515	1019	15.6	989×10^4	50×10^4	5.2	.08
			24	7162	998	13.9	955×10^4	57×10^4	5.7	.08
	General Average			6971	893	12.8	959×10^4	61×10^4	6.3	.08

Modulus of Elasticity	Average Deflection	Average Load	Maximum Thickness	Minimum Thickness	Average Thickness	Number of Pieces Tested	Actual Impact	Average Impact for One Inch Thickness	Maximum Thickness	Minimum Thickness	Average Thickness	Impact Modulus of Rupture
.3	.149	13.24	.186	.150		24	.080	.825	.183	.155	.168	597
.1	.125	12.24	.189	.160		24	.074	.437	.191	.160	.172	561
.8	.148	13.80	.187	.159		25	.099	.573	.188	.154	.173	632
.6	.142	12.72	.187	.153		25	.104	.602	.201	.150	.172	640
.1	.132	13.00	.189	.154		24	.083	.477	.195	.160	.177	579
.4	.137	13.00	.188	.155	.171		.088	.581	.192	.156	.172	604
.2	.116	18.00	.222	.182		25	.100	.509	.215	.180	.196	599
.8	.109	20.60	.249	.202		18	.104	.545	.243	.203	.221	579
.7	.109	20.60	.230	.192		21	.122	.563	.230	.209	.218	637
.3	.107	21.00	.226	.198		23	.111	.506	.234	.207	.218	669
.0	.107	19.80	.238	.202		22	.100	.445	.237	.204	.215	563
.6	.109	20.00	.235	.195	.212		.107	.513	.232	.201	.214	595
.7	.085	34.24	.299	.261		25	.122	.422	.312	.244	.290	538
.6	.079	34.60	.309	.250		25	.116	.422	.306	.250	.275	562
.5	.082	36.00	.310	.272		25	.115	.435	.300	.250	.274	538
.5	.071	31.00	.306	.257		25	.110	.407	.300	.243	.274	543
.0	.077	31.80	.296	.258		25	.111	.402	.295	.257	.276	522
.8	.079	33.53	.304	.260	.280		.116	.418	.303	.249	.278	541
.0	.064	75.00	.433	.356		25	.208	.516	.428	.361	.403	575
.7	.068	75.40	.424	.386		23	.196	.503	.415	.394	.407	547
.4	.068	77.00	.427	.393		22	.220	.545	.427	.398	.412	562
.6	.060	66.60	.424	.397		23	.189	.462	.424	.397	.411	531
.2	.065	73.00	.420	.386		24	.197	.468	.427	.395	.409	533
.7	.065	73.40	.426	.384	.406		.202	.499	.424	.389	.408	549
.0	.093	37.12	.295	.275	.284	7	.122	.426	.301	.287	.298	545
.2	.096	55.80	.328	.260		25	.240	.790	.339	.260	.311	749
.4	.108	55.40	.351	.260		25	.237	.749	.356	.282	.306	729
.3	.104	55.80	.342	.249		25	.225	.719	.350	.249	.295	741
.8	.101	50.60	.349	.262		25	.266	.813	.360	.280	.309	756
.5	.105	55.40	.355	.269		25	.312	.639	.340	.258	.308	839
.6	.103	54.60	.345	.260	.301		.256	.742	.349	.266	.306	765
.1	.127	14.60	.165	.141		26	.103	.651	.165	.141	.152	901
.3	.133	14.20	.158	.145		25	.108	.642	.194	.140	.165	857
.1	.129	15.00	.187	.170		24	.101	.589	.186	.161	.178	776
.5	.130	14.60	.170	.152	.161	25	.104	.627	.182	.147	.165	845
.5	.097	28.20	.268	.241		24	.133	.533	.268	.241	.256	576
.9	.098	30.20	.275	.247		25	.137	.514	.273	.245	.259	609
.4	.098	37.00	.265	.235		29	.153	.591	.271	.246	.259	646
.5	.098	31.80	.269	.241	.255		.141	.546	.271	.244	.257	610
.9	.102	37.00	.276	.251	.263	71	.180	.649	.280	.255	.264	699
.3	.105	44.20	.316	.256		26	.166	.586	.310	.250	.277	645
.5	.107	46.20	.316	.271		23	.148	.557	.305	.260	.278	620
.3	.103	48.60	.300	.262		13	.190	.621	.306	.258	.283	684
.5	.103	49.40	.308	.272		25	.191	.680	.303	.267	.288	691
.2	.108	52.20	.308	.282		23	.187	.644	.312	.269	.297	665
.5	.105	48.12	.309	.269	.284		.176	.618	.307	.261	.284	661
.7	.087	79.80	.390	.331		22	.204	.524	.390	.327	.362	614
.5	.085	84.60	.412	.352		26	.220	.585	.414	.355	.379	634
.7	.084	93.16	.415	.357		25	.195	.498	.407	.357	.379	588
.2	.086	85.00	.403	.353		24	.210	.592	.400	.352	.373	626
.7	.082	85.16	.415	.360		25	.263	.691	.411	.356	.379	683
.3	.085	85.54	.407	.351	.378		.212	.578	.404	.349	.374	629

Factory Number	Style of Glass	Number of Pieces Tested	Average Modulus of Rupture	Average Variation from Mean Modulus	Per Cent Variation from Mean Modulus	Average Modulus of Elasticity	Average Variation from Mean Elasticity	Per Cent Variation from Mean Elasticity	Average
2	1/8" Rough Wire	25	5200	523	10.0	847×10^4	67×10^4	7.9	.0
		24	5160	241	4.6	872×10^4	41×10^4	4.7	.0
		25	5300	561	10.5	873×10^4	48×10^4	5.6	.0
	General Average	25	5220	441	8.4	864×10^4	52×10^4	6.1	.0
2	1/4" Ribbed Wire (Brown)	78	6200	700	11.2	896×10^4	71×10^4	7.9	.1
2	1/4" Ribbed Wire	25	5220	266	5.1	954×10^4	47×10^4	4.9	.0
		24	5480	503	9.2	955×10^4	77×10^4	8.0	.0
		25	7320	879	11.8	1215×10^4	85×10^4	7.0	.1
	General Average		6007	549	8.7	1041×10^4	69×10^4	6.6	.0
1	1/4" Ribbed Wire	24	5263	275	5.4	939×10^4	40×10^4	4.2	.0
		24	5350	306	5.2	975×10^4	23×10^4	2.3	.0
		24	5150	463	8.9	963×10^4	41×10^4	4.3	.0
		25	5418	390	7.7	947×10^4	44×10^4	4.6	.0
		25	5123	389	7.5	940×10^4	59×10^4	6.2	.0
	General Average		5261	365	6.8	957×10^4	41×10^4	4.3	.0
2	1/8" Ribbed Wire	25	5660	729	11.1	879×10^4	68×10^4	7.7	.0
		25	5950	853	14.3	874×10^4	69×10^4	7.8	.0
		24	6430	809	12.5	831×10^4	58×10^4	7.0	.0
	General Average		6013	797	13.3	861×10^4	65×10^4	7.5	.0
1	1/8" Ribbed Wire	25	5750	582	11.2	969×10^4	52×10^4	5.3	.0
		24	5457	556	10.2	938×10^4	72×10^4	7.5	.0
		15	5576	215	3.8	942×10^4	59×10^4	6.0	.0
		25	5460	327	6.0	972×10^4	54×10^4	5.5	.0
		25	5940	573	9.6	960×10^4	58×10^4	6.0	.0
	General Average		5636	450	8.1	956×10^4	59×10^4	6.0	.0
2	1/8" Corrugated Wire—1/4" depth	25	9700	1538	15.8	372×10^4	45×10^4	11.3	.0
		25	10000	1260	10.2	373×10^4	26×10^4	7.0	.0
		24	9100	1415	15.5	349×10^4	33×10^4	9.5	.0
	General Average		9600	1404	13.8	365×10^4	35×10^4	9.3	.0
2	1/8" Corrugated Wire—1"d.—(Colored)	15	15450	1410	9.1	616×10^4	59×10^4	9.5	.0
		22	17450	1555	8.5	622×10^4	65×10^4	10.4	.0
		20	15100	1282	8.4	618×10^4	51×10^4	8.2	.0
	General Average		16000	1416	8.7	619×10^4	58×10^4	9.4	.0
2	1/8" Corrugated Wire—1"d.	22	12080	1490	11.4	548×10^4	24×10^4	4.3	.0
		24	14700	1420	10.6	635×10^4	51×10^4	8.0	.0
		22	13350	1520	11.4	588×10^4	52×10^4	5.7	.0
	General Average		13343	1480	11.1	587×10^4	42×10^4	7.0	.0
2	1/8" Aqueduct	75	4820	675	12.7	688×10^4	42×10^4	6.1	.0

from Mean Elasticity	Average Deflection	Average Load	Maximum Thickness	Minimum Thickness	Average Thickness	Number of Pieces Tested	Actual Impact	Average Impact for One Inch Thickness	Maximum Thickness	Minimum Thickness	Average Thickness	Impact Modulus of Rupture
.9	.068	60.20	.385	.358		25	.212	.551	.386	.369	.372	583
.7	.066	59.00	.385	.368		25	.201	.498	.402	.362	.376	572
.6	.073	59.80	.386	.365		24	.189	.508	.388	.362	.376	556
.1	.069	59.66	.385	.364	.375	25	.201	.519	.392	.364	.374	570
.9	.109	37.80	.289	.251	.277	76	.184	.630	.290	.268	.280	646
.9	.084	29.00	.273	.250		25	.138	.508	.279	.259	.268	588
.0	.093	31.00	.277	.256		25	.145	.603	.275	.225	.246	630
.0	.104	31.80	.260	.226		24	.142	.620	.247	.228	.239	712
.6	.094	30.60	.270	.244	.253		.142	.612	.267	.237	.250	643
.2	.076	42.20	.324	.293		26	.127	.415	.328	.295	.304	525
.3	.080	40.20	.320	.289		24	.140	.449	.322	.290	.308	558
.3	.077	42.60	.325	.296		25	.143	.495	.321	.293	.307	561
.6	.083	45.00	.323	.288		15	.135	.453	.320	.298	.307	541
.2	.079	41.00	.330	.290		22	.145	.465	.329	.301	.313	553
.3	.079	42.20	.324	.291	.307		.138	.455	.324	.295	.308	548
.7	.074	68.20	.394	.357		11	.247	.650	.388	.375	.382	626
.8	.076	74.20	.409	.351		25	.255	.624	.398	.367	.384	639
.0	.081	42.60	.392	.361		26	.281	.733	.392	.367	.384	654
.5	.077	61.67	.398	.356	.381		.261	.669	.393	.369	.383	640
.3	.069	64.60	.384	.354		24	.157	.435	.386	.351	.362	543
.5	.071	61.40	.385	.351		25	.157	.433	.390	.351	.362	535
.0	.070	65.80	.404	.346		25	.150	.429	.373	.349	.357	527
.5	.071	63.80	.400	.351		25	.156	.423	.400	.344	.366	539
.0	.075	66.60	.395	.343		25	.158	.432	.395	.351	.366	539
.0	.071	64.46	.394	.349	.365		.156	.430	.389	.349	.363	537
.3	.043	120.60	.344	.317		25	.323	.974	.344	.317	.331	505
.0	.048	125.00	.348	.316		25	.309	.922	.354	.315	.334	490
.5	.041	107.00	.365	.323		20	.301	.932	.347	.320	.336	469
.3	.044	117.53	.352	.319	.335		.311	.943	.348	.317	.334	488
.5	.044	154.20	.324	.303		24	.277	.879	.337	.304	.316	616
.4	.042	158.60	.339	.290		25	.303	.938	.333	.310	.322	641
.2	.037	167.80	.336	.296		24	.266	.856	.323	.292	.309	612
.4	.041	160.20	.333	.296	.318		.282	.891	.331	.302	.316	623
.3	.040	150.60	.337	.320		24	.258	.798	.369	.319	.336	544
.0	.039	155.80	.323	.307		25	.269	.817	.355	.310	.331	602
.7	.037	154.20	.355	.311		25	.297	.903	.352	.316	.330	609
0	.039	153.53	.338	.313	.327		.278	.849	.359	.315	.332	585
1	.087	48.52	.373	.323	.348	68	.194	.600	.358	.315	.342	524

The tup was then released from the magnet so that it struck the glass at right angles to the plane of the sample. Repeated blows were struck with forces increasing in increments of .025 ft. lb. until a break occurred.

Results of Tests

The accompanying Table I shows in detail the results obtained from both tests. It indicates the amount of variation which may be expected from such tests and in case of the rough rolled and wire glass, the variation of the product of a factory from day to day is also shown.

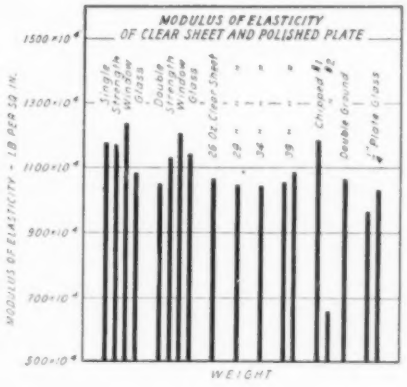


FIG. 4.

The diagrams shown in Figs. 1, 2, 3 and 6 compare with the values obtained for modulus of rupture and the actual loads required to break the test specimens. Where more than one value is given in the diagrams for the same type and thickness of glass, each value represents that obtained for the product of a different manufacturer. The values obtained for modulus of elasticity (Young's modulus) shown in Figs. 4, 5 and 6 are calculated, using the deflection values and loads obtained in the crossbreaking tests. The thicknesses shown in Figs. 1, 2, 4, 5 and 6 are the trade thicknesses of the glass, the thicknesses shown in Figs. 3, 7 and 8 are the actual thicknesses found, and aid in getting a true comparison of the strength. The results of impact tests are shown in Figs. 7, 8 and 9. An attempt has been made to express these results on a basis of the strength of the material with respect to unit thickness. A comparison obtained by a direct calculation of the proportionate strength of samples one inch thick is shown in Fig. 8, and a comparison on the basis of an impact modulus is shown in Fig. 9.

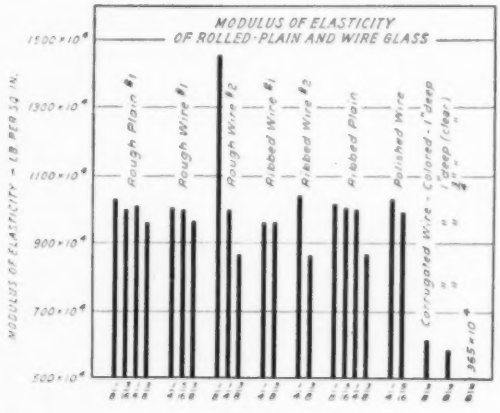


FIG. 5.

The impact modulus was calculated from the formula shown below, developed by Dr. L. B. Tuckerman, of this Bureau.

$$S = 18 \frac{E}{AL} W$$

E = Young's modulus
A = Cross-sectional area of sample
L = Length of span
W = Work in ft. lbs. to obtain a break
S = Impact modulus in ft. lbs. per sq. in.

All shock effects are neglected in this computation and the calculations made as if the glass under impact were quasi-stationary.

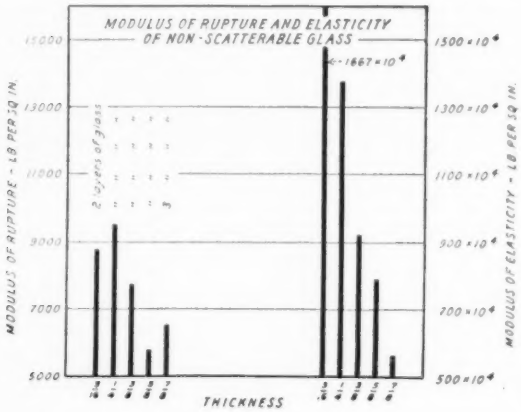

MODULUS OF RUPTURE AND ELASTICITY
OF NON-SCATTERABLE GLASS
MODULUS OF RUPTURE - LB PER SQ. IN.
MODULUS OF ELASTICITY - LB PER SQ. IN.
THICKNESS

FIG. 6.

Stress strain diagrams for three thicknesses of window glass and a wire glass are shown on Figs. 10, 11, 12 and 13.

Brief Discussion of Results

Considering the type of material being tested and the fact that all samples contain a number of minute cracks and scratches, the uniformity of results seems to be quite good.

All samples have diamond-cut edges which are, therefore, probably fractured or chipped to a considerable extent. The polished glass might in addition contain considerable minute fractures under the polished surface.[1] All of these fractures tend to reduce the strength of the glass below the theoretical value which is probably considerably greater than any obtained. Breaking the glass with the diamond cut uppermost might give an increased strength over samples broken with the cut edges down, owing to the

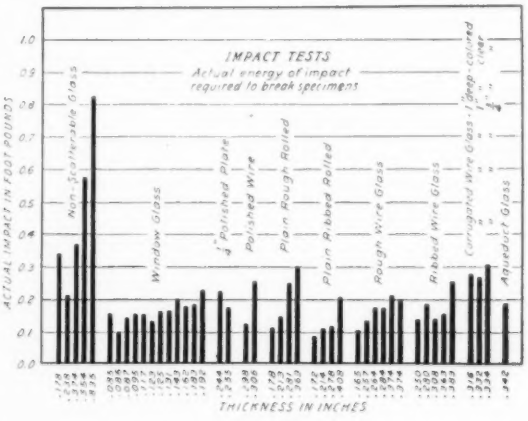


FIG. 7.

[1] "The Structure of Abraded Glass Surfaces," *Trans. Optical Soc.*, **23** [3], 141 (1921–22).

fact that the fractures are then put in compression rather than in tension. This factor was not considered in tests, however, except that where samples of clear sheet glass showed some bow the sample was tested with the convex side of the bow down, so that the diamond cut is always on the same side, *i. e.*, the upper side in this case.

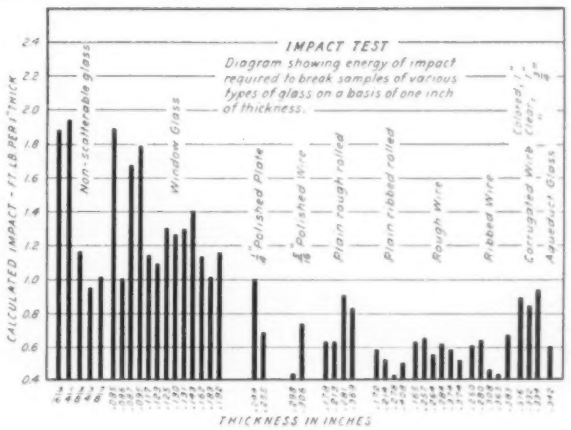

IMPACT TEST
Diagram showing energy of impact required to break samples of various types of glass on a basis of one inch of thickness.
CALCULATED IMPACT - FT. LB PER 1" THICK
Non-scatterable glass
Window Glass
1/8" Polished Plate
3/16" Polished Wire
Plain rough rolled
Plain ribbed rolled
Rough Wire
Ribbed Wire
Corrugated Wire
Colored, 1" Clear, 1/4"
Approach Glass
THICKNESS IN INCHES

FIG. 8.

All processed glass was tested with processed side up, which is the position of greatest strength under the conditions of the test. The results indicate that the strength of the glass has not been reduced to any extent when tested in such a position.

The following Table II, shows the maximum and minimum values for modulus of rupture obtained from any single group of samples of various types of glass:

TABLE II

LIMITING VALUES OBTAINED FOR MODULUS OF RUPTURE IN LBS. PER SQ. IN.

Rolled Figured Sheet	Plain Rough Rolled Glass	8625– 5500
	Ribbed Rolled Glass	5714– 4671
Wire Glass	Plain Rough Wire Glass	7900– 5640
	Ribbed Rolled Wire Glass	7320– 5220
	Corrugated Wire Glass (1″ deep)	17450–12980
	Corrugated Wire Glass (3/4″ deep)	10000– 9100
	Polished Wire Glass	7470– 5569
Polished Plate Glass		6997– 6027
Special Nonscatterable Glass		9500– 5750
Clear Sheet Glass (Window Glass)		12775– 6111

The following values for modulus of rupture may be considered as safe working strength for various types of glass.

	Lbs. per sq. in.
Single strength or double strength window glass and 26 oz. clear sheet glass	7000
29 oz.–34 oz. and 39 oz. or 3/16″ clear sheet glass and 1/4″ plate	6500
Rolled sheet and wire glass	6500
Ribbed rolled sheet or wire glass	5300
Corrugated wire (1″ deep)	13500
Corrugated wire (3/4″ deep)	9500

VALUES FOR YOUNGS' MODULUS FOR VARIOUS TYPES OF GLASS

		Lbs. per sq. in.
Single and double strength window glass		11,000,000
26 oz., 29 oz., 34 oz., 39 oz. clear sheet glass		10,500,000
Polished plate glass		10,000,000
Rough rolled glass		9,700,000
Nonscatterable glass—varies greatly with thickness	3/16"	16,670,000
	7/8"	5,500,000

Comparing clear sheet glass with polished plate or rough rolled plate glass, the former is somewhat the stronger. Ribbed glass gives a low value, but that may be explained in part because the thickness used in the calculations was taken to the top of the rib rather than at the base or an intermediate point between. As the glass is sold on a basis of thickness measured to that point the strength is relative.

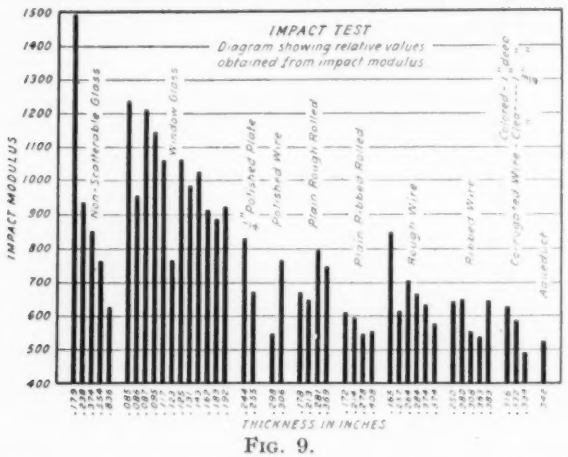


FIG. 9.

Generally speaking, thin glass shows greater strength per unit thickness than thick glass both under slow loading and under impact. Figures 1, 2, 6 and 9 will show this fact. The rather high strength developed by the corrugated glass under slow loading as compared to its strength under impact is also worthy of notice. Tests to determine the strength of glass in frames are now being made both with respect to its resistance to impact, to slow loading in the center and to uniform loading over the entire area. Results of these tests will be published at a later date.

The values obtained for modulus of elasticity also decrease with the thickness of the glass rather consistently, this fact being especially noticeable in the laminated nonscatterable glass.

Stress strain relations indicate a truly elastic body, all curves obtained being practically straight lines. Experiments were also tried to show whether or not the glass returned to its original position when the load was removed. Load was applied, then removed, then an increased load applied and removed up to the breaking point, the samples in all cases returning to their original position. Long continued loading might have deformed the samples as might be expected of plastic or viscous substance,

but the glass exhibits all the properties of a solid within the time limits of the tests.

The results obtained from impact tests do not show the same rate of increase in strength with increase in thickness as is shown for breaks ob-

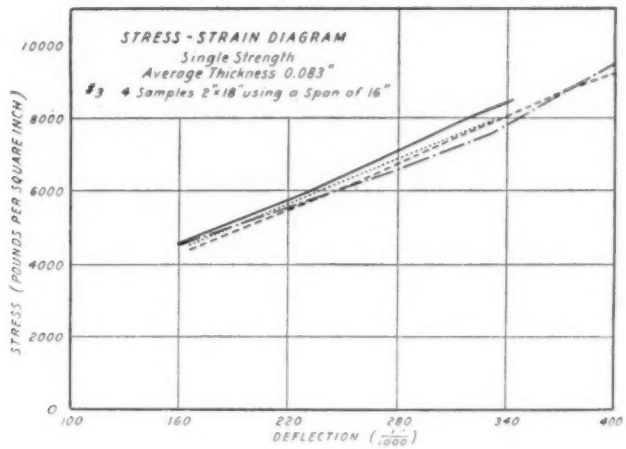


FIG. 10.

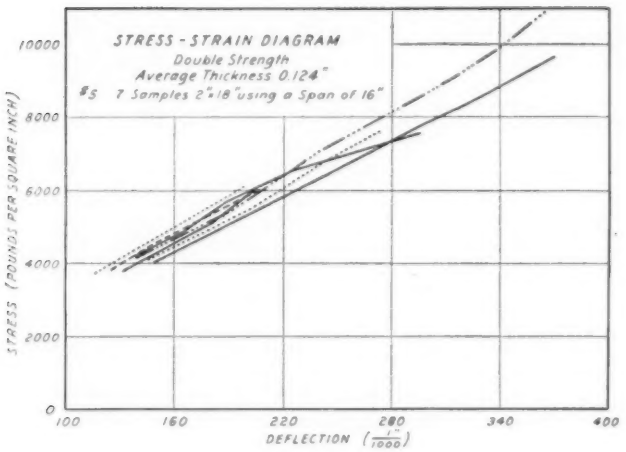


FIG. 11.

tained by slow loading. That is, the load required for a break increases approximately as the square of the thickness, whereas the impact required for a break increases in about a direct proportion to the thickness.

Experiments indicated that uniform results in terms of energy could not be obtained if different sized hammers were used, striking at different

velocities to produce a break. Heavier hammers at lower velocities broke the glass with less energy than light hammers with high velocity. This indicates that results are probably not theoretically comparable, as the same hammer striking at different velocities was the way in which the results were obtained. Geometrically proportional samples broken

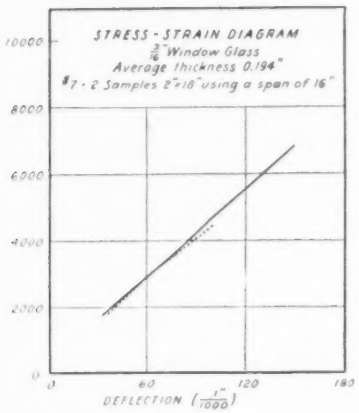


FIG. 12.

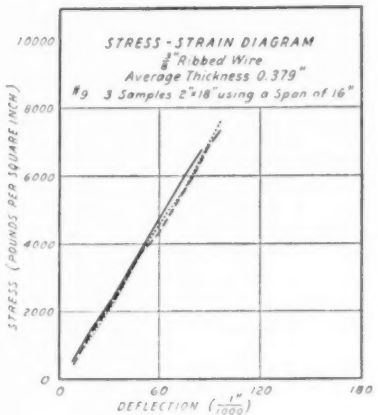


FIG. 13.

with hammers varying in size, so that a uniform velocity of blow would be obtained for breaking each sample, would probably give values more nearly approaching the true strength of the glass. Such a method of testing would hardly be practical, as a simple method of testing glass.

BUREAU OF STANDARDS
WASHINGTON, D. C.

EFFECT OF HYDROGEN ION CONCENTRATION UPON CLAY SUSPENSIONS[1]

By F. P. Hall

ABSTRACT

This paper includes a preliminary report on the study of clay suspensions. Two methods commonly used for measuring the hydrogen and hydroxyl ion concentrations of aqueous solution are outlined. The hydrogen ion concentration of the water extract from several clays is given. The effect of the hydrogen ion concentration of the suspending medium on the rate of settling of suspended clay is given for several different clays. The action of alkali on suspended clay is studied.

Introduction

The effect of electrolytes on stabilizing and precipitating clay suspensions has long been studied. In general it may be deduced from previous researches that the hydrogen ion is a flocculator and the hydroxyl ion a deflocculator of clay suspensions. A great deal of work[2] has been done on the study of the amount of electrolyte required to flocculate and deflocculate clay suspensions, but very little work has been done to determine the hydrogen ion concentration that the required amount of electrolyte will produce in the solution. It is the object of this investigation to study the hydrogen ion concentration or degree of acidity of various clay suspensions with varying amounts of electrolytes and attempt to correlate these facts with any known properties of the clays. While this paper deals only with the effect of hydrogen and hydroxyl ion concentration on clay suspensions, we realize that other ions have a marked effect on the rate of settling of suspensions. The valence of the ion is a very important factor. However, the case is simplified by considering only univalent ions, H^+ and OH^-.

A careful distinction must be drawn between the amount of acid or total acid concentration and the hydrogen ion concentration or degree of acidity. The distinction is just as important as in the parallel case of quantity of heat and degree of heat or temperature. Solutions of .01 N hydrochloric acid and .01 N acetic acid contain equivalent amounts or concentrations of acids, as determined by titration with standard alkali (to appropriate end points), but the hydrogen ion concentration in the case of the strong acid (HCl) will be about .01 N while the hydrogen ion concentration in the case of the weak acid (acetic acid) will be about 0.0004 N.

Various methods are used to express the hydrogen ion concentration, illustrated by the following examples, all of which indicate the same concentration of hydrogen ions.

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce. Recd. May 17, 1923.

[2] Bureau of Standards, *Tech. Paper*, No. **23.**

(1) $\frac{1}{100{,}000}\ N$

(2) $.00001\ N$

(3) $1 \times 10^{-5}\ N$

(4) pH 5.0

The fourth method proposed by Sörensen and often called the Sörensen value or the pH value is used throughout this article. The expression "pH" involves the logarithm of the reciprocal of the hydrogen ion concentration ($pH = \log 1/H^+$). The dissociation constant of water at 25°C is about 10^{-14} and since in pure water $H^+ = OH^-$ then the pH value of pure water is 7.0. As compared with water, a solution with a pH value less than 7 is acid while one greater than 7 is alkaline.

Methods of Measurement of the Hydrogen Ion Concentration of Aqueous Solutions

The two principal methods of measuring the hydrogen ion concentration are (1) by the use of the hydrogen electrode and (2) a colorimetric method involving the use of dyes or indicators whose constants have been determined by the use of the hydrogen electrode. Methods for using the hydrogen electrode are described fully by W. M. Clark.[1] The apparatus recommended by Clark was used in this work and consisted of a Clark hydrogen electrode outfit—1, Leeds and Northrup type K. potentiometer and galvanometer. A tenth normal calomel electrode was used with a connecting cell filled with saturated potassium chloride. The Bjerrum extrapolation was not made.

The colorimetric method devised by L. J. Gillespie[2] was employed only when clear solutions were to be examined, because any appreciable amount of clay adsorbs the color reagent and vitiates the results. In the case of unbuffered solutions it is best to use the indicators if possible. Both the indicators and the hydrogen electrode were checked against standard buffer solutions before each series of solutions was examined. By buffer action we mean the resistance exhibited by a solution to change in pH through the addition or loss of acid or alkali. The buffer action of a solution is dependent upon the character and concentration of the constituents. Weak acids and bases in the presence of their salts exhibit buffer action which is greatest in concentrated solutions. O. Arrhenius[3] has shown that soils possess buffer action. Some soils exhibit it to a greater extent than others. This buffer action in soils is probably due to the presence of organic acids.

[1] "The Determination of Hydrogen Ions," by W. M. Clark, Williams and Wilkins Co., Baltimore, 1922.

[2] "Colorimeteric Determination of the Hydrogen Ion Concentration without Buffer Solutions, with Special Reference to Soils," *Soil Science*, **9** [2], 115 (1920).

[3] O. Arrhenius, "The Potential Acidity of Soils," *Soil Science*, **1922.**

The Hydrogen Ion Concentration of the Water Extract from Several Clays

Table I gives the results of the examination of the water extracts from a number of clays. As the pH value[1] is dependent on the relative amounts of clay and water present, the ratio of water to clay was the same in every test except one. This ratio of water to clay denoted as w/c was 4. The values given are those obtained with the hydrogen electrode but they were checked by the colorimetric method. In general the colorimetric method gave higher results from .1 to .2 in pH value.

TABLE I

THE pH VALUE OF THE WATER EXTRACT FROM SEVERAL CLAYS

$\frac{w}{c} = \frac{4}{1}$.

Clay	pH	Clay	pH
Kaolins and shales		Ball Clays	
South Carolina kaolin	4.40	Lk. Knowles No. 1	4.15
English china	5.20	Lk. Knowles No. 2	4.50
English china	5.45	Lk. Knowles No. 12	5.95
Bentonite	9.72[a]	Whitway ball clay	4.40
N. Carolina kaolin	4.75	P. M. C. Co. ball clay 90	5.65
Delaware kaolin	5.10	Pooles Pike	5.25
Virginia kaolin	5.05	Superior B. C.	3.80
Penna. clay	5.75	Blue ball clay	3.65
Fla. kaolin	5.90	J. P. T. B. No. 11	5.65
Ga. kaolin	4.15	Dorset E. B	4.10
Shale (N. W. T. C. Co.)	6.70	Cooley	5.00
Hyd. P. B. Co. clay	7.27	M. &. M. No. 11	3.85
Fallston fire clay	8.40	Fayles	3.90
Cutters No. 2	2.95	Grindley	5.75
H. & W. fire clay	5.00	M. &. M. No. 18	5.70
Stoneware grog	6.10	J. P. Tenn. B. No. 10	5.55
Met. Pav. shale	6.30	J. P. Tenn. B. No. 9	5.50
Crossly No. 1	3.70	English ball	4.65
Colorado clay	3.10	Tenn. ball No. 3	3.20
Fla. kaolin	6.80	Ky. ball No. 4	5.20
		German clay	3.85

[a] $\frac{w}{c} = \frac{350}{5}$

Values given to nearest .05.

An examination of the results presented shows that the pH value of the extracts examined varies from 3 to 8.5. The ball clays in general give no stronger acid extracts than the kaolins. There does not seem to be any generalization that can be made in this respect.

A great deal of acidity of the extract is due to the soluble salts present

[1] This has been illustrated in an article by R. M. Salter and M. F. Morgan, entitled, "Factors Affecting Soil Reaction," which was published in the *Journal of Physical Chemistry*, **27**, 117 (1923).

but just how much cannot be said because of the difficulty of removing adsorbed salts. Table II shows the result of washing out part of the salt. Two hundred grams of water were mixed with 50 grams of clay and the pH of this extract was determined. Then the water was decanted off

TABLE II

EFFECT OF WASHING SOLUBLE SALTS OUT OF CLAY

Clay (pH) $\frac{w}{c} = \frac{4}{1}$	1st extract	3rd extract	6th extract	9th extract	12th extract
South Carolina kaolin	4.40	4.70		4.70	4.75
Ga. kaolin	4.15	4.25	4.80	4.70	4.75
Tenn. ball No. 3	3.20	3.40	3.65	3.70	3.80
English china	5.45	5.65	5.75	5.80	6.15
Fallston fire clay	8.40	8.15	8.05	7.80	7.20

Effect of Aging of Clay on pH of Water Extract

Clay $\frac{w}{c} = \frac{4}{1}$	Initial	after 53 days	after 130 days
German ball	3.85	4.20	4.20
Ky. ball No. 4	5.20	5.05	4.80
		After 7 months	After 2 years
Clay mixture X		4.12	3.78

(the clays examined were flocculated at this pH) and another 200 grams of water added and this procedure was repeated twelve times. In generla a clay that gives an acid extract with the first addition of water will decrease in acidity as successive amounts of water are added. Clays giving an alkaline extract will usually decrease in alkalinity as they are washed.

Table II also shows the results of tests carried out on clays that have aged. The clays were thoroughly pugged and then stored in a damp atmosphere. Samples of the clays were taken from time to time and the pH value of the water extract determined. G. A. Bole[1] suggests that the increased plasticity of clays caused by aging might be due to increase of hydrogen ions. The change in the latter is only slight as is shown in the Table. In two cases there is an increase in hydrogen ions and in another a decrease. From the small amount of data obtained it would be impossible to say whether or not aging increases the hydrogen ion concentration of the clay-water mixture. It is possible that the aging causes a hydration of the gel colloid and this in turn increases plasticity.

The Rate of Settling of a Clay Suspension as a Function of the Hydrogen Ion Concentration of the Suspending Medium

In order to obtain results that can be duplicated in the study of the rate of settling of suspensions it was found to be necessary to follow exactly the same procedure in making up all of the suspensions. The temperature

[1] Mechanism of the Plasticity of Clays, *Jour. Amer. Ceramic Soc.*, **5**, 469 (1922).

of the suspension must be closely controlled and the order of addition of clay and electrolyte to the water must be the same in every case. The same is true of the time of agitation of the suspension. In the present investigation the suspensions were made in graduated glass cylinders and the time required for the material to settle a certain distance was determined. From this data the average rate of settling was calculated. Each curve shown in Figs. 1 and 2 shows a maximum and a minimum rate. The point at which the material shows a maximum rate of settling is commonly called the iso-electric point while that at which it shows a minimum is called the point of maximum degree of deflocculation. The time that a clay will remain suspended depends to a great extent on the time that the suspension is agitated. For instance, if a clay suspension at about the point of maximum deflocculation is agitated for a day, a part of the clay will remain suspended indefinitely.

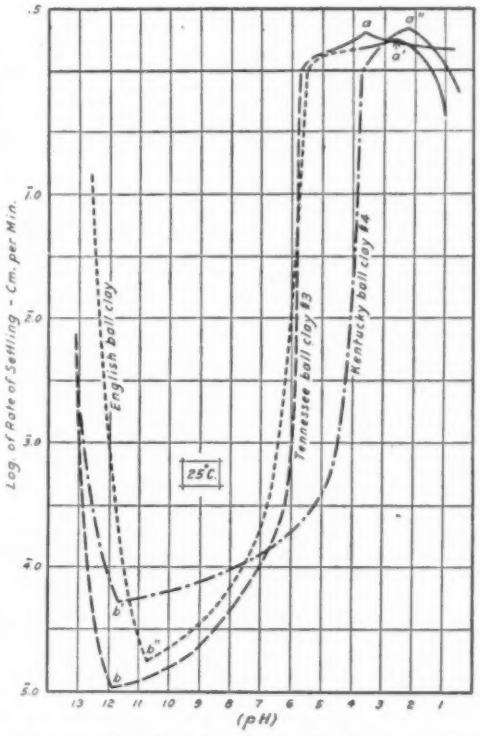


FIG. 1.—Showing the relation between the rate of settling of three ball clays and the pH value of the suspending medium. The full lines indicate the average rate of settling of the flocculated clay and the broken lines indicate the rate of settling of the finest particles over the deflocculated range. Points a, a', a'', are the iso-electric points while b, b', b'', are the points of maximum deflocculation. The electrolytes used were sodium hydroxide and hydrochloric acid.

O. Arrhenius[1] obtained curves very similar to those shown in Figs. 1 and 2 but he shows that the iso-electric point of a clay suspension is very sharp. This we did not find to be true in the case of the clays that were examined. Arrhenius examined two clays and found the iso-electric point of the two clays to be at the same pH. We found that the iso-electric point of the several clays was not exactly at the same pH but lies between pH 2.7–4.0, depending on the character of the clay. The point of maximum deflocculation varies from pH 11–12. Neither of these points is very sharp and both vary with the ratio w/c.

[1] Olof Arrhenius, "Clay as an Ampholyte," *Jour. Amer. Chem. Soc.*, **44**, 521 (1922).

This failure to find a sharp iso-electric[1] point is probably due to the fact that clays contain a mixture of colloids such as silica, alumina, etc. If we were dealing with one colloid rather than a mixture we would expect to find a sharp iso-electric point. In Table III the iso-electric points and points of maximum deflocculation are tabulated for several clays.

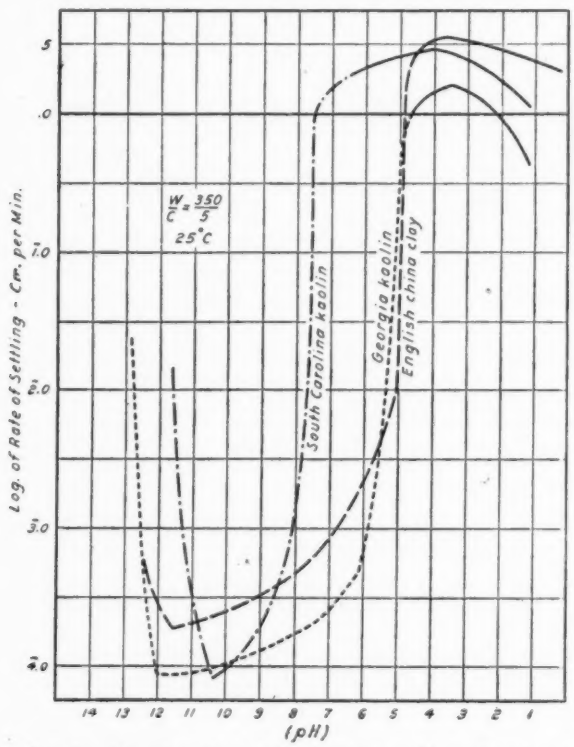


FIG. 2.—Showing the relation between the rate of settling of three kaolins and the pH value of the suspending medium. The full lines indicate the average rate of settling of the flocculated clay and the broken lines indicate the rate of settling of the finest particles over the deflocculated range.

The Action of Alkali and Acid on Suspended Clays[2]

If a quantity of alkali is added to water the pH value of the water is increased and if the same quantity of alkali is added to the same volume of a clay suspension the pH is increased but not as much as with water alone, due to the action of the alkali on the clay. This is shown in Fig. 4 in the case of the Florida kaolin. Here the heavy line denotes the effect of the addition of 0.1 N sodium hy-

[1] A. W. Thomas and M. W. Kelly, *Jour. Amer. Chem. Soc.*, **44**, 206 (1922), do not obtain a sharp iso-electric for collagen and conclude that collagen is a mixture rather than one simple protein.

[2] Geller and Caldwell (*Jour. Amer. Ceram. Soc.*, **4** [6], 479 (1921) made a study of the action of alkali on clay. They found that alkali was adsorbed by the clay. Their method of examination was different from that outlined in this article. They attempted to titrate the alkali that did not react with the clay by centrifuging the suspension and separating the clay from the alkaline solution. They were not able to separate all of the colloidal matter from the suspending medium. Therefore, when they titrated the solution containing suspended matter they disturbed the adsorption equilibrium and did not determine the actual amount of alkali adsorbed. This accounts for the difference between the two constants K and $1/n$ as determined by them and as given in Table V of this paper.

TABLE III

TABULATION OF pH VALUES OF CLAY SUSPENSIONS

$\frac{w}{c} = \frac{350 \text{ cc.}}{5 \text{ grams}}$

Clay	pH of water extract	pH at isoelectric pt.	pH at point of maximum deflocculation
English ball	5.50	2.78	10.96
Tenn. ball No. 3	3.80	3.63	12.01
Ky. ball No. 4	5.50	2.28	11.97
English china	5.80	3.63	11.60
Ga. kaolin	4.70	3.42	12.00
S. Carolina kaolin	4.80	3.99	10.32

TABLE IV

RATE OF ACTION OF ALKALI ON CLAY

Value of pH of Solution at Certain Intervals

Clay	6 hours	1 day	2 days	3 days
Fla. kaolin	9.43	9.39	9.39	9.38
Fla. kaolin	10.78	10.70	10.70	10.68
Fla. kaolin	11.37	11.30	11.29	11.28
Fla. kaolin	11.65	11.52	11.52	11.51

droxide to 350 cc. of conductivity water. Under similar conditions acids also react with the clays as is shown in Fig. 3. The procedure in obtaining the data given in Figs. 3 and 4 was as follows: the electrolyte was added to the water, next the clay was added and then the solution was agitated and placed in a bath at 25°C. After 24 hours the pH value of the suspension was determined. The solution was further agitated and the pH again determined after an additional 24 hours. From the data shown in Table IV it is evident that the action was practically complete in 24 hours. This was true of all the clays except bentonite which required three days to reach equilibrium. From the amount of alkali added to a suspension and the pH value of the suspending medium at equilibrium it is possible to calculate the amount of alkali that has been taken out of solution by the clay.

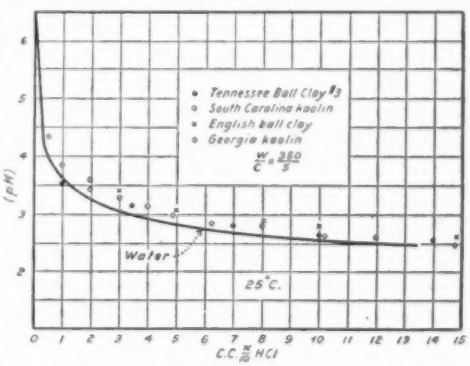


FIG. 3.—Showing that acids are absorbed by clays. In this paper the term "absorption" is used to designate the removal from solution of a dissolved substance, by a solid, regardless of the mechanism by which it occurs. "Adsorption" is considered as a special form of absorption, characterized by the accumulation of the dissolved substance upon the surface of the solid.

There are three ways by which this alkali could be removed from solu-

tion by the clay: chemical action, physical adsorption, and solid solutions. There is still a great deal of controversy concerning methods of distinguishing between these several actions, especially when one of the phases is in an extremely subdivided state. It is probable that there is no hard and fast distinction between these actions when dealing with substances in the colloidal state, that is to say, there is probably an overlapping of these actions and it is very difficult to say whether a certain action is purely physical adsorption or chemical action, or both. However, in presenting data concerning actions of this type it is well for the investigator to give his interpretation of his results. Sometimes this interpretation is not agreeable to all, which is often due to a question of definitions.

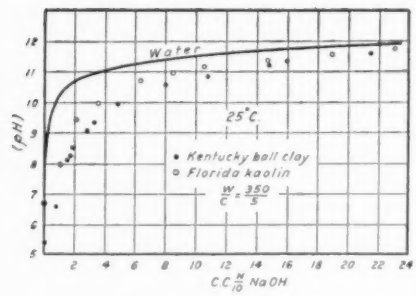


FIG. 4.—Showing that part of the alkali is removed from the solution by the suspended clay.

When dealing with systems of this nature (clay-water-electrolyte) where the surface of the solid phase is very great, it is reasonable to expect that a great part of the electrolyte that is removed from solution is adsorbed on the surface of the solid phase. An equation has been used by Freundlich and others connecting the quantity of material adsorbed and the quantity of adsorbent. This equation is

$$\frac{x}{m} = KC^{\frac{1}{n}}$$

where x is the amount of material in grams adsorbed by m grams of the solid adsorbing agent, C is the concentration in the solution after adsorption, *i. e.*, the equilibrium concentration, and K and n (where $n>1$) are constants for a given solute and adsorbent. In this consideration the adsorbent is clay and the solute is sodium hydroxide. K is the amount of solute adsorbed when the concentration is unity. This should be proportional to the amount of surface of the solid phase. The amount

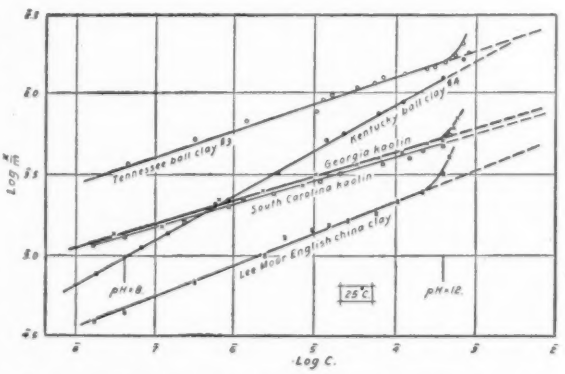


FIG. 5.—Illustrating an approximate straight line relation between log. C and log. x/m over a range of concentration between pH 7 and 12.

of surface exposed is dependent on the degree of subdivision of the solid phase. In fact the value of K should be an index of the degree of subdivision. The value of $1/n$ is the rate of change of log x/m with log C. In cases of purely physical adsorption the value of log x/m should be a straight line function of log C. If log x/m is not a straight line function of log C and the curve passes through a maximum, this is an indication of chemical action. The results of plotting the values of log x/m against log C for a number of experiments are shown in Figs. 5 and 6. It is evident that there is a straight line log relation between x/m and log C, between pH 7 and 12. It is probable that between these values of concentration that the action of alkali on clay is primarily due to physical adsorption. However, at concentrations of alkali greater than pH 12 (pOH 2) it seems likely that chemical action plays an important rôle. This is also illustrated in Fig. 7 where at concentrations greater than approximately pH 12 (pOH 2) the percentage of sodium hydroxide taken out of solution by the clay increases.

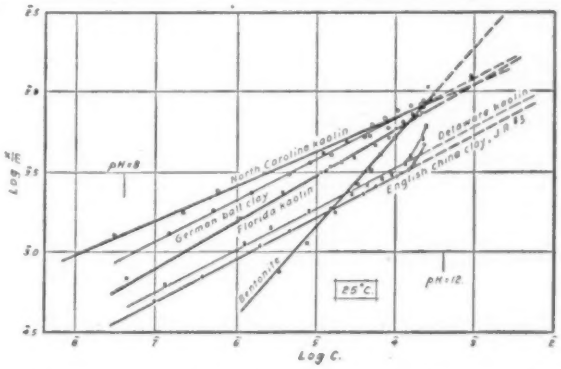


FIG. 6.—Illustrating an approximate straight line relation between log C and log x/m over a range of concentration between pH 7 and 12.

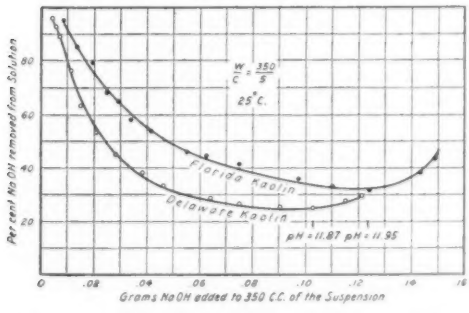


FIG. 7.—Showing that the percentage of alkali reacting with clay decreases with increase in concentration of alkali until a concentration of approximately pH 12 is reached. In concentration greater than pH 12 the reverse is true.

The values of the constants K and n are tabulated in Table V. If K is a correct index of the degree of fineness of the clay the arrangement shown in Table V is a classification of the clays according to degree of fineness. It is highly probable that the value of K as determined is affected by the presence of adsorbed salts that were originally in the clays. It is probable that the first small quantities of alkali are taken out of solution by the adsorbed salts, that is, by chemical reaction.

TABLE V

TABULATION OF CLAYS IN ORDER OF DESCENDING VALUE OF K

Clay	K	$1/n$	n
1. Bentonite	.89	.58	1.72
2. Kentucky ball clay No. 4	.107	.27	3.70
3. Florida kaolin	.089	.33	3.03
4. German ball clay	.080	.29	3.45
5. Tenn. ball clay No. 3	.056	.16	6.26
6. North Carolina kaolin	.047	.21	4.75
7. Delaware kaolin	.036	.26	3.85
8. English china J. R. No. 3	.032	.26	3.85
9. Georgia kaolin	.017	.15	6.70
10. S. Carolina kaolin	.015	.14	7.15
11. Lee Moor English china	.012	.19	5.25

Summary

1. No generalizations can be based upon the examination of the pH of the water extracts from a number of clays. That is, all ball clays do not give a more acid extract than all kaolins and *vice versa*.

2. For every clay-water-electrolyte mixture there exists a certain pH (the iso-electric point) at which the rate of settling of the clay is a maximum and a pH at which the rate is a minimum (the point of maximum deflocculation). Neither of these points is very sharp. This may be due to the fact that we are dealing with a mixture of colloids and not with a single colloid. It is evident that a knowledge of these two points (iso-electric point and point of maximum deflocculation) would be advantageous in a number of processes, namely: purification of clay, purification of water[1] and casting of clay bodies.

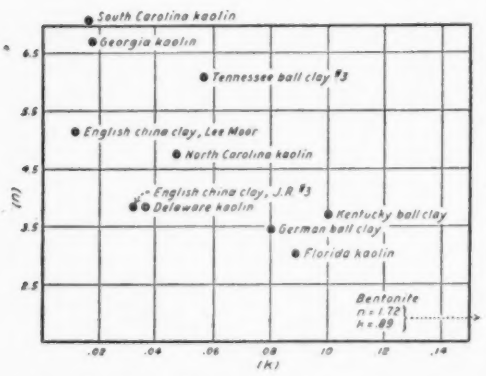


FIG. 8—The value of K and n as determined for a number of clays when the material adsorbed is sodium hydroxide.

3. The action of alkali on clay over the range pH 7–12 can be explained

[1] An article on this subject appeared, at about the time this manuscript was completed, in the *Journal of the American Water Works Association*, **10,** May, 1923, entitled, "The Use of Acid with Alum in Water Purification and the Importance of Hydrogen Ion Concentration," by J. R. Bayliss.

Another article on this subject is, "An Experimental Study of the Relation of Hydrogen Ion Concentration to the Formation of Floc in Alum Solutions," *Public Health Reports*, **38,** 5, 181, by Emery J. Therrault and W. M. Clark.

in certain cases as due primarily to adsorption. Above pH 12 the action seems to be primarily chemical rather than physical.

4. The value of K (one of the constants of the adsorption equation) as determined for a number of clays, might be used as a rough index of the degree of fineness of the clay. It is evident that the value of K could not be used as an exact index of the degree of fineness of the material because if we consider two solid phases with equal surfaces the activity of the two substances toward a given material is seldom the same. The adsorption of any substance by a solid is a function of the specific surface of the solid and is also dependent on the activity of the substance towards the material that is adsorbed.

Appendix[1]

S. E. Mattson[2] has published some interesting results on the study of flocculation and deflocculation of clay suspensions. He studied the velocity of migration of clay and quartz particles suspended in water, under a drop of electrical potential. As the charge in the particle increases, the velocity of migration increases. Mattson found the clay particles were negatively charged and as the suspending medium was made acid the velocity decreased, and with a further increase in acidity the particle became positively charged. Thus the iso-electric point is passed on the acid side. The addition of alkali to a clay suspension increases the negative charge on the particles until a certain point is reached where further addition of alkali decreases the charge on the particles. This point of maximum charge occurs in the region of maximum deflocculation. The point of maximum rate of settling occurs at the iso-electric point where the charge on the particles is zero. The point of maximum deflocculation occurs at the point where the particles have the maximum charge. This seems to be a good explanation of the action of acids and alkalies on clay suspensions.

[1] Received August 1, 1923.

[2] "Die Beziehungen zwischen Ausflockung, Adsorption und Terlchenladung mit besonderer Berucksichtigung der Hydrox yliouen," *Kolloidchemischen Beiheften*, **14** [9–12], 272.

THE CHEMISTRY OF THE TERPENE MEDIUM FOR CERAMIC LIQUID GOLD

By P. P. Budnikoff and E. A. Shilov

The preparation for gilding ceramic wares was invented by Doctor Kühn in Meissen. Due to its highly valuable qualities this preparation very soon won a universal renown. The golden powder, which previously was used exclusively, besides being very expensive, had many inconveniences.

The principal substances used for the preparation of gold for overglaze gilding of pottery through fire are turpentine,[1] lavender and other oils, sulphur and gold chlorides. Turpentine is boiled with 20% of sulphur in an oil bath under a return condenser for several hours. To the reaction product obtained ("sulphury balsam"), gold chloride is added. In order to fasten the gold on to the surface of the pottery, a small quantity of flux is added.[2]

One of the principal conditions for a proper formation of a glazing golden coating after burning is that the gold must remain in a colloidal solution.

On the basis of our experimental work, we became convinced that (1) no solid compounds whatever, *i. e.*, precipitates containing gold such as gold sulphide, gold mercaptide etc., mixed with fluxes would produce a glazing coating; and (2) that no solution of gold compounds would produce a glazing lamina. It seemed necessary to have the gold in a compound that would be changed into gold sulphide just at the moment the heat caused the solvent to disappear. Such complex compounds of gold as the thio derivatives of the terpenes in solution (probably colloidally) in excess of solvent seemed to fulfill such requirements. Our experiments have proved to us the nature of these thio derivatives of terpenes.

After several hours of boiling sulphur with terpenes,[3] we observe a plain, dense, brownish-red liquid with a sharp specific odor, and soluble in many common organic solvents. This reaction is accompanied by the scanty productions of H_2S.[4] When heated in a vacuum or under atmospheric

[1] The Russian turpentine, as our studies have proved is not fit for such a purpose, for it possesses reducing qualities. In a given preparation, gold precipitates little by little in the shape of metallic gold which can easily be observed through a microscope. The lamina after burning in the muffle acquires in the latter case a dead gold surface.

[2] Duterte. Dingler's *Polyt. Tourn.*, **161,** 44, **182,** 265; Carre, Sulvetat in Brogniart Tr., **11,** 721; Schwarz, Dingler's *Polyt. Tourn.*, **197,** 243; Gentele, Wagner's *Tahresberichte* (1856), 178; P. Budnikoff, The News of Tvanovo-Voznessensk, *Polytech. Inst.*, **6,** 211 (1922).

[3] We began the study of this reaction with the chemically pure pinene (boiling point 155–156 °C) rectified over metallic sodium in an atmosphere of CO_2 but because of the Russian conditions we were obliged to adapt the Russian turpentine, choosing the fraction 170–175 °C.

[4] When boiling 3% of sulphur solution in turpentine for 70 hours, about $2^1/_2$% of the sulphur employed is transformed into hydrogensulphide.

pressure, it was observed that the higher the boiling point, the greater its sulphur content. (See Tables I, II, and III.)

TABLE I

DATA PRODUCT AFTER DISTILLING IN VACUUM

Substance	Pressure	Boiling point	Refraction	Dispersion	Content of sulphur	Weight
Terpene	750 mm.	155–156°	1.467	39.5		240 gr.
Product of reaction			1.560	38.7		
1st fraction	20	60–70°	1.474	38.9	0.4%	17 gr.
2nd fraction	15	70–90°	1.484	38.5	3.9%	15 gr.
3rd fraction	15	90–120°	1.494	37.75	6.4%	44 gr.
4th fraction	15	120–140°	1.530	36.3	14.6%	32 gr.

TABLE II

PRODUCT RECTIFIED BY ATMOSPHERIC PRESSURE

Substance	Boiling point	Refraction	Dispersion	Content of sulphur	Weight
Terpene	170–175°	1.4739	39.4		
Product of Reaction		1.560	38.3		350 gr.
1st Fraction	160–175°	1.469	39.2	3.91%	101 gr.
2nd Fraction	175–185°	1.481	38.9	7.62%	42 gr.
3rd Fraction	185–200°	1.490	38.6	9.64%	36 gr.
4th Fraction	200–210°	1.548	38.4	12.76%	13 gr.

TABLE III

PRODUCTS ACQUIRED IN ATMOSPHERE OF CO_2

Substance	Boiling Point	Per cent Content S	Weight
Terpene	155–156°		
Product of Reaction with Sulphur in the Atmosphere CO_2			350 gr.
1st Fraction	147–161°	3.0	112 gr.
2nd Fraction	161–165°	4.6	29 gr.
3rd Fraction	165–170°	11.8	10 gr.
4th Fraction	170–200°	13.1	16 gr.

About 50% of turpentine remains in the distillational flask in the shape of pitch, little fit for investigation. We did not succeed in obtaining a substance with a constant boiling point from the products of the reaction.

In 1908 Erdmann[1] tried to explain the reaction between sulphur and the terpenes. As a starting point he took the hypothesis that the group S_3, (analogous to ozone) combines with many chemical compounds. By the action of sulphur on the products of terpenes at a high temperature the group S_3 is always combined in the place of the double bond giving as result compounds which he calls thiozonides.

Thus, only one molecule of terpene can be united with three or its multiple number of atoms of sulphur. Erdmann states that there can be no other compounds. As much as we can judge, Erdmann did not succeed

[1] Liebig's, *Annalen*, **362,** 133.

in obtaining individual chemical compounds by which he could justify his point of view. Our investigations[1] did not confirm Erdmann's opinions, for we did succeed in obtaining one definite chemical compound containing one atom of sulphur for one molecule of terpene. We obtained it by treating the reaction products with CH_3I at ordinary temperature whereby fine crystals precipitated little by little. These we found could be dissolved in absolute alcohol and precipitated by ether. This compound melts with decomposition at about 121°C, but at a lower temperature it becomes brownish. We must remember that we had not the definite terpene but a mixture.

The ultimate analysis shows that the crystalline precipitate from the interaction of CH_3I on the reaction product between sulphur and the terpenes corresponds in its composition to the formula:

$C_{10}H_{16}SCH_3I$.
0.1500 gr. of substance gave 0.0799 gr. H_2O and 0.2337 gr. CO_2
0.1000 gr. of substance gave 0.0755 gr. AgI
0.2380 gr. of substance gave 0.1718 gr. $BaSO_4$ (Liebig[2])
0.1880 gr. of substance gave 0.1239 gr. $BaSO_4$ (Dennstedt)

Found:	Calculated for $C_{10}H_{16}SCH_3I$:
C—42.50%	42.57%
H— 5.99%	6.17%
I— 40.50%	40.92%
S— 9.90%	
S— 9.52%	

This compound, as we shall see, further appears to be a typical sulphonium salt, and that is the reason that we called it methylterpensulphonium-iodide.

This iodide is easily soluble in water, but decomposes slowly when boiled. It contains iodine in a ionogen state: when $AgNO_3$ is added the halogen is quickly precipitated in the form of AgI. Its solution in water conducts the electric current just as well as solution NaI. [The molecular conductivity $C_{10}H_{16}SCH_3I$ at 25°C (1/100 N) = 114,[7] NaI = 112[5] (1/128 N).][3]

With moist silver hydroxide it gives a strong base, which precipitates the heavy metals and liberates ammonia from compounds. This base,

[1] P. Budnikoff and E. A. Shilov, "About the Action of Sulphur and Sulphur Compounds on the Terpenes," News of Tvanovo Vosnessensk, *Polytechnical Institute*, No. **4**, 6, 7 (1921–1922).

[2] It is interesting to observe that the acidation at the rate of L. Carius can be produced with great difficulty, even when heating to 300°C with HNO_3 of density 1.52 for 20 hours. It is evident that sulphones are produced which are transformed with difficulty into sulphuric acid.

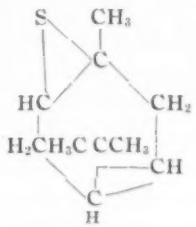
[3] Landolt, p. 1112. Latest ed.

when boiled with water, decomposes, producing a transparent oil with a peculiar odor, which is probably $C_{10}H_{16}S$.

In order to decide the question about the structure of this compound it is important to observe that sulphur, according to the point of view of the coördination theory of Werner, must be combined with two atoms of carbon, for, otherwise, a sulphonium salt could not be formed with CH_3I. It is probable that this compound is the first step of the interaction of sulphur on the terpenes. The terpenmonosulphide just formed combines with more sulphur, giving the polysulphides of the terpenes.

In case such an over-grouping did not occur, the sulphur then must be combined in the double position.

For the pinenes it can be expressed in the following formula:—



The methylterpensulphoniumiodide gives complex compounds with mercuryiodide; $C_{10}H_{16}SCH_3I.HgI_2$ and $C_{10}H_{16}SCH_3I_2.HgI_2$. We obtain the first compound if, according to the method of Samuel Smiles,[1] we add the theoretical quantity of mercury iodide to the solution of methylterpensulphoniumiodide in acetone and precipitate with ether.

To prepare the complex compound $C_{10}H_{16}SCH_3I.HgI_2$, 0.88 gram of $C_{10}H_{16}SCH_3I$ were dissolved in 30 cc. of acetone by slightly heating. The solution thus obtained was filtered, then shaken with 1.2 grams HgI_2, whereby HgI_2 was dissolved. The turbid solution was filtered and, when transparent, 150 cc. of dry ether were added. The precipitate was filtered and washed six times with ether, dried in the open air and then in the desiccator, yielding 1.16 gr.

$C_{10}H_{16}SCH_3S.HgI_2$ presented under a microscope small oblique prisms. It is soluble in acetone but not in water. H_2S will precipitate HgS slowly and not completely from such an acetone solution. This is the reason why, in the analysis, we destroyed the compound with strong HNO_3 and determined the mercury according to the method of Volhard.[2] The iodine on the contrary is precipitated easily by $AgNO_3$ in the presence of HNO_3.

0.2591 gr. of substance yield 0.0790 gr. HgS
0.1953 gr. of substance yield 0.1799 gr. AgI

[1] *J. Chem. Soc.*, **77,** 163 (1900), **91,** 1394 (1907).

[2] F. P. Treedwell, *Lehrbuch der analytischen Chemie.*, II, Band Quant. anal. (5 Aufl.) 5.139.

$C_{10}H_{16}SCH_3I.HgI_2$ calculated for		Found:
Hg—	26.18%	26.27%
I—	49.85%	49.82%

The compound of methylterpensulphoniumiodide with two molecules of mercury iodide is also easily obtained if we take calculated quantities of components in acetone solution. Having evaporated the acetone in the vacuum, we obtained, when seen in the microscope, lemon-yellow, elongated, oblique prisms.

For the preparation of the complex $C_{10}H_{16}S.CH_3I_2HgI_2$, 0.746 grams of $C_{10}H_{16}S.CH_3I$ were dissolved in 40 cc. of acetone, by slight heating. We then added 2.183 grams of HgI_2, whereby all the mercury iodide passed into the solution. The yellowish precipitate obtained was filtered, then evaporated in a flat crystallizing dish, filtered, washed in a mixture of 1 volume of acetone with 2 volumes of ether and dried in the open air.

$C_{10}H_{16}S.CH_3I.2HgI_2$ decomposes at a temperature somewhat higher than 100°C. It is rather readily soluble in acetone, less soluble in alcohol and slightly soluble in chloroform and ether. It is insoluble in water, but is destroyed in a dilute solution of potassium iodide, yielding a pale yellow precipitate which probably is the compound of methylterpensulphoniumiodide with one molecule of mercury iodide.

0.1847 gr. of substance gave 0.1773 gr. AgI
0.1352 gr. of substance gave 0.0512 gr. HgS

$C_{10}H_{16}S.CH_3I.2HgI_2$ calculated for		Found:
T—	51.69%	51.89%
Flg—	32.58%	32.63%

According to this method we can add AsI_3 to the methylterpensulphoniumiodide and obtain good orange or deep red crystals, soluble in acetone and alcohol.

$C_{10}H_{16}S.CH_3I.AsI_3$ is soluble in water, giving a colorless solution that has an acid reaction. This indicates a decomposition of this complex compound in the water.

0.2023 gr. of substance gave 0.2666 gr. AgI
0.1733 gr. of substance gave 0.0260 gr. As_2S_3

$C_{10}H_{16}SCH_3I.AsI_3$ calculated for:		Found:
I—	66.2%	65.4%
As—	9.7%	9.1%

The double salt of arsenic iodide with methylterpensulphoniumiodide oxidizes easily in the air, yielding As_2O_3.

The solution of $AuCl_3$ in alcohol precipitates black crystals of $C_{10}H_{16}S.CH_3I.AuI_3$ from solution of methylterpensulphoniumiodide.

Calculated:	Found:
Au 22.2	22.4

Accordingly we can consider it proved that the sulphur, when acting on the terpenes, gives terpenmonosulphide.

If we add to the distillates some "sulphury balsam" spirit solutions of salts of heavy metals ($AuCl_3$, $PtCl_4$, $Pb(CH_3COO)_2$, $HgCl_2$ and others) we obtain rather slightly soluble precipitates which are unsuited for analysis.

In these complex compounds the metal is immediately combined with the sulphur of the terpenmonosulphide. When heated or acted on by steam they produce a metal sulphide. If we prepare such a precipitate with gold chloride and coat glazing pottery with it, we shall obtain, after calcination, a bright coating of gold. Evidently the grains of this product are too big. In the industries, in order to obtain a preparation of gold the "sulphury balsam" must act on the water solution of gold chloride, whereby the gold chloride which enters slowly into chemical combination with terpensulphides, being extracted from the water solution, will not precipitate, if the "sulphury balsam" is properly prepared, but remain in solution probably as a colloidal suspension. In the latter case the grains of the complex compound of gold are so small that when heated in a muffle to 250–300° we see a black mirror of gold sulphide coating the pottery, which upon further heating passes into SO_2 and Au in the shape of a fine bright crystalline coating.

We can obtain monosulphide $C_{10}H_{16}S$ with far better success by the action S_2Cl_2 on the terpenes. The reaction goes on vigorously in the cold. After heating the products of reaction in an oil bath under a reflux condenser for several hours, CH_3I precipitates the same methylterpensulphoniumiodide, and approximately in double the quantity as when free sulphur is used. At the same time the terpenes react with chlorine, since during the reaction hydrogen chloride is abundantly evolved. On the sides of the flask at the top of the liquid, after cooling, white crystals of pinenechlorhydrate are produced which have a melting point of 131°. Adding to the fractions of the product obtained an alcoholic solution of $AuCl_3$, a red thick oil separates out.

This oil, dissolved in turpentine, gives after calcination a fine crystalline golden coating on the pottery.

The chlorinated terpenes appear to be good non-reducing solvents for the complex compounds of gold chloride and the thioderivatives of terpenes.

It is interesting to observe that with this method of preparing a liquid preparation of gold, we can use Russian turpentine, because S_2Cl_2 appears to be an oxidizing agent for the reducible substances in Russian turpentine.

For the preparation of "sulphury balsam," Paul Koch in a German patent N. 219,121[1] and N. 236,490[2] points to the possibility of using the

[1] Friedlander IX, **1094,** *Fortschritte der Teer farbenfabrication.*

[2] *Ibid.*, **1305.**

polysulphides of sodium and potassium but he did not isolate the terpen-monosulphides and did not even state the possibility of their formation. Although we did not note an important increase of sulphur in the products of distillation, we did obtain a reaction at 120° which produced a smaller quantity of pitch. Perhaps the further study of this method will give more satisfactory results.[1]

NOTE: The authors wish to express their most sincere gratitude to the assistant, N. T. Voznessensky, who assisted in this work.

[1] If we boil the polysulphides with the terpenes under a reflux condenser for a longer time the products of reaction will produce a sulphur dyestuff of a chocolate color.

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LABORATORY OF MINERAL TECHNOLOGY.
NOVEMBER, 6 1922.

PANEL TESTS OF LIME PLASTER[1]

By W. E. Emley and E. B. Berger

A previous research on this subject[2] indicated that the popping which sometimes occurs as a defect in lime plaster is caused by the slow hydration and expansion of certain impurities which might be present in the lime or sand. It seemed that large particles of almost any substance, even though it were not subject to hydration, might work loose and fall out, leaving an unsightly hole in the plaster. Small particles, on the other hand, do not usually cause trouble, even though they are susceptible to hydration and expansion. It seems that the small particles hydrate before the plaster has set, or the magnitude of the expansive force is not sufficient to loosen the particle, or, if the particle does fall out, the hole which it leaves is too small to be readily noticeable.

On the basis of the above, a proposal was made to require hydrated lime to be of such fineness that it would all pass a No. 50 sieve. But before accepting such a radical proposal, it was felt that a much more extensive investigation should be made.

Accordingly, under the sponsorship of the Lime Committee of the A.S.T.M., 98 panels of lime plaster have been erected at this Bureau. The Bureau conducted the necessary laboratory work to show the quality of the materials, furnished the space for the panels, and made the examination of their condition. The panels were erected by the Contracting Plasterers National Association, of materials furnished by the National Lime Association, and the plaster was applied by the Operative Plasterers International Union. The work was completed on March 4, 1922.

Prior to the application of the plaster, thirteen brands of hydrate were examined chemically and microscopically. From the information thus obtained, and from similar examinations of sands, certain impurities were selected as being likely to be present and to cause trouble. One of these materials, for example, was calcium carbonate in the form of "core". Some "core" was obtained from a lime manufacturer, ground, and screened to three sizes: all through a No. 14 sieve and retained on a No. 30 sieve; all through a No. 30 sieve and retained on a No. 50 sieve; and all through a No. 50 sieve. One of the hydrates was selected, and used as a finish coat for one panel, permitting the plasterer to use his own judgment about consistency and gaging with gypsum. A mixture of 9 parts by weight of this hydrate with 1 part of the coarse core was used for the second panel. In the same manner, medium and fine core was added to the finish coat for the third and fourth panels respectively. Each panel

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce. Recd. May 9, 1923.

[2] W. E. Emley and C. H. Bacon, "Soundness of Lime Plaster," *Jour. Amer. Ceram. Soc.*, **3** [11], 877 (1920).

was duplicated, as a check, and the same procedure was followed for each of the impurities selected.

The panels became one year old on March 4, 1923. Their condition at that date was as follows:

Hydrate No. 1 (Ohio), plus core.
Panels Nos. 1 to 4 and 50 to 53.

All panels in good condition, showing that the presence of core, even though coarse, is not deleterious.

Hydrate No. 2 (Ohio), plus sand.
Panels Nos. 5 to 8 and 54 to 57.

All three sizes of sand caused popping, but the duplicate panels did not check this, except in the coarse size. The coarse size causes popping more quickly than the fine. It seems that differential expansion and contraction causes the sand grains to become loose and fall out.

Hydrate No. 3 (Ohio), plus over-burned lime.
Panels Nos. 9 to 12 and 58 to 61.

This over-burned lime was so badly over-burned as to be hard and yellow, and it could be immersed in water for six hours without noticeable effect. The hydrate itself was slightly unsound, as evidenced by a few small pops in the plain panels. The effect of the over-burned lime is very marked. In the fine size, it has produced blisters; in the coarse size, it has caused complete disintegration of the finish coat.

Hydrate No. 4 (Pennsylvania), plus magnesia.
Panels Nos. 13 to 16 and 62 to 65.

The hydrate itself shows a few pops, and the magnesia is apparently without effect. This is "light calcined" or "caustic" magnesia, which probably hydrated when the lime was soaked before use. Hydrates Nos. 1, 2, 3, 4, 6, 9, and 11 are dolomitic, and contain the usual hard burned magnesia.

Hydrate No. 5 (Vermont), plus iron carbonate.
Panels Nos. 17 to 20 and 66 to 69.

The hydrate itself shows a few pops and cracks. The additions of iron carbonate seem to have no effect.

Hydrate No. 6 (Ohio), plus quicklime.
Panels Nos. 21 to 24 and 70 to 73.

This hydrate also was not entirely sound. The quicklime used was well burned, quick slaking material. Probably most of it hydrated during the soaking prior to use. The fine quicklime shows no noticeable effect; the medium shows a few additional pops; and the popping of the coarse particles is quite apparent.

Hydrate No. 7 (Texas), plus pyrites.
Panels Nos. 25 to 28 and 74 to 77.

The plain hydrate panels, and those with fine pyrites, show traces of popping. The medium and coarse particles of pyrites show distinct evidence that they will cause popping, the time required for the pop to appear depending upon the size of the particle.

Hydrate No. 8 (California), plus magnesium sulphate.
Panels Nos. 29 to 32 and 78 to 81.

This impurity seems to have no effect. All panels are in good condition.

Hydrate No. 9 (Pennsylvania), plus sodium chloride.
Panels Nos. 33 to 36 and 82 to 85.

The hydrate shows traces of unsoundness, which are not increased by the impurity. However, sodium chloride produces efflorescence, which is very bad when the material is fine, but not so bad with the coarse salt.

Hydrate No. 10 (Maine), plus lime burned during hydration.
Panels Nos. 37 to 40 and 86 to 89.

The term "lime burned during hydration" is used to describe the coarse hard particles produced when lime is hydrated with an insufficient amount of water. This material was made in the Bureau laboratory. The coarse particles caused a few pops; with the medium size, the pops are almost negligible; and the fine material caused no popping.

Hydrate No. 11 (Ohio), (Panels 41, 42, 90 and 91).
Plus mica (fine) Nos. 43 and 92.
Plus tannic acid (fine) Nos. 44 and 93.

The mica had no effect. Tannic acid retards the setting of the lime so much that the panels remained soft for two months. The surface is badly checked and discolored.

Hydrate No. 12 (Tennessee), plus clay.
Panels Nos. 45 to 48 and 94 to 97.

The clay used is known as Tennessee ball clay, and is quite plastic. The hydrate itself was not entirely sound. The clay, in medium or coarse sizes, may have caused some cracking. The fine size had no effect.

Hydrate No. 13 (Missouri).
Panels Nos. 49 and 98.

This hydrate was noticeably unsound.

Summary

No deleterious effect was produced by adding to the finish coat 10% by weight of core, magnesia, iron carbonate, magnesium sulphate, mica, or clay.

Particles coarser than a No. 50 sieve are apt to cause trouble if the material added is sand, quicklime, pyrites, or lime burned during hydration.

Overburned lime, salt, or tannic acid is bad regardless of the size of the particles.

The length of time required for popping to develop depends upon the size of the particles. Of the 13 hydrates used, eight showed some pops, which usually appeared about the end of the fifth month. This tendency to unsoundness is exaggerated by the severity of the examination to which the panels were subjected, and is of no commercial significance.

Conclusions

The following principles are recommended as the basis for a specification covering the soundness of hydrated lime or lime putty:

Examine microscopically to insure the absence of calcium oxide (index of refraction = 1.81).

Wash the sample through a No. 50 sieve. Dry and weigh the residue and figure it as per cent of the sample. If the residue is more than 5%, it should be analyzed. If this is found to be anything other than calcium carbonate, the sample should be rejected.

Pyrites can hardly occur in lime, but may be a constituent of the sand. A specification for sand is required, which should also carry limits on the quantity of salt and organic matter permissible.

CERAMIC ABSTRACTS

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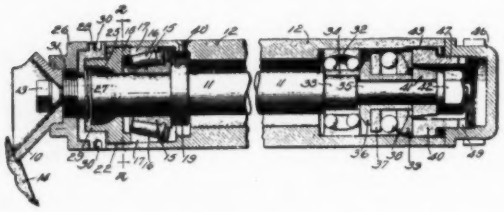
[1] The abbreviation (*C. A.*) at the end of an abstract indicates that the abstract was secured from the Editor of *Chemical Abstracts* by coöperative agreement.

Abrasives

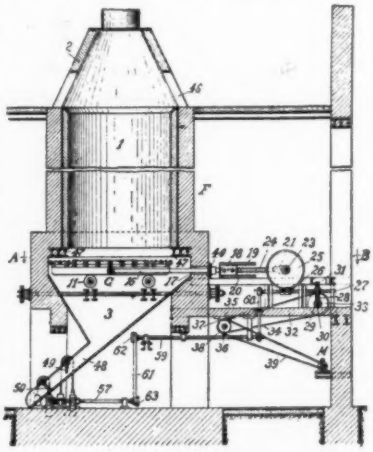
PATENT

1. Dressing tool for grinding wheels. THURE LARSSON. U. S. 1,455,213, May 21. A dressing tool for grinding wheels comprising an open ended housing, a rotatable shaft mounted therein and having one end projecting therefrom, a cutting disk on the projecting end, means to exclude dust from the inside of the housing, adjustable radial bearings within the housing adjacent said projecting end of the shaft, radial bearings for the opposite end of the shaft, adjustable bearings for receiving end thrust only, and means for positively adjusting each set of said adjustable bearings independently of the other set to take up radial and longitudinal wear.



Cement, Lime and Plaster

2. Slump test for concrete. ANON. *Indus. Australian & Mining Standard*, **59**, 757(1923).—In order to standardize mixts. of concrete to a definite specification the "slump" test may be employed. Newly mixed concrete is placed in a mold, and lightly tamped, which when filled is removed immediately and the settlement of the concrete noted. If the slump or settlement is not in accordance with the specifications the amt. of water can be increased or decreased as may be required. For stiff concrete, the slump should not exceed 2" and concrete of this consistency will require punning. For a concrete which will flow around reinforcement, a slump of 6" is suitable, and if the reinforcement be intricate, this quantity may be slightly increased. The amount of variation in the quantity of water is not great, and this test is very sensitive and delicate; an increase of 10% in the quantity of water will increase the slump by several inches. The mold is made of metal, in the form of a hollow truncated cone about one foot long, 4" in diameter at the top, and 8" in diameter at the base, and provided with handles at the sides. The test can be made in a few minutes, and by its adoption the strength of concrete structures will be more uniform. At the present time expts. are being conducted to develop a method, that will enable the volume of water to be detd. for each given slump. O. P. R. O.



PATENT

3. Continuous furnace for burning cement and the like. RUDOLF THIELE. U. S. 1,451,379. A continuous furnace of the character described, having a shearing-grate consisting of grate-sections adapted to be reciprocated in their own plane in opposite directions to each other, clinker-crushing teeth on said sections and means for reciprocating said grate-sections.

Glass

4. Accurate glass tubes, manufactured by the Küpper process. ANON. *Chem. Age*, **8**, 615(1923).—The Küpper process for the manufacture of glass tubes with absolutely accurate internal diameters was subject of a rept. recently made to the Aix la Chapelle section of the German Chemists. According to the "Küpper" process an accurately cylindrical metal core is inserted into the drawn glass tube; thereupon the tube is evacuated and the outside is slowly heated up. Thus the glass becomes soft and the outer atmospheric pressure forces the walls into intimate contact with the metal core so that the interior of the tube takes exactly the dimensions of the metal core. The glass tube has a higher coeff. of exp. than the metal core: after cooling, therefore, the core can easily be withdrawn from the tube and may be inserted into another tube to be calibrated without any prepn. being required. A great number of tubes made by the Küpper process was presented at the meeting, and it was demonstrated that one metal plunger fitted a number of precision syringes with equal accuracy. O. P. R. O.

5. Electrical properties of flint glass of density 6.01. G. L. ADDENBROOKE. *Phil. Mag.*, **45**, 516–25(1923).—Hopkinson (*Trans. Roy. Soc. London*, **1878**) announced that the ratio K/D is approx. const. for all glasses over a range from $D = 2.87$ to 4.5, where D is density and K is the dielec. const. A. employs a glass of approx. compn.: SiO_2 22%, PbO 78%, and of d. 6.01. Fragments were used employing the method of mixts. Details of the elec. method and the calcn. are given. The very high dielec. const. 13 was obtained, giving a K/D value that fits in well with those of Hopkinson. The ratio K/N^2 (N is the index of refraction of the D line) is 3.55, the highest ever found for any normal substance. The evidence indicates that the glass is a true compd., $PbSiO_3$ dissolved in an excess of SiO_2, and not merely a mixt. of SiO_2 and PbO.

S. C. (*C. A.*)

6. Progress in the glass industry. LEON APPERT. *Bull. soc. encour. ind. nat.*, **134**, 728–65(1923). E. H. (*C. A.*)

7. Gas producer and furnace practice in the glass industry. RICH. SCHNEIDER. *Glashütte*, **52**, 625–7, 641–2, 657–8, 673–6, 689–93, 707–8, 723–4, 755–6, 771–2, 787–8 (1922); 26 figs. J. B. P. (*C. A.*)

Heavy Clay Products

8. Scumming on roofing tile. ANON. *Tonind. Ztg.*, **47**, 272(1923).—Sol. salts in clay cause scumming on roofing tile which has heretofore been prevented by the addn. of $BaCO_3$ to the clay. The price of $BaCO_3$ is, however, becoming so high that many manufs. were forced to abandon the use of this preventative. Some manufs. have succeeded in reducing the amt. of $BaCO_3$ by adding a certain percentage of finely ground sand. This sand is ground to a powder in a ball mill. Since the sand contains practically no sol. salts while the clay does, the amt. of $BaCO_3$ required is reduced in propn. to the amt. of sand added. H. G. SCHURECHT

9. Handling clay with belt conveyors. STAFF ARTICLE. *Brick and Clay Record*, **62**, 1136–7(1923).—Description of the system used for clay storage at Don Valley Brick Co., Toronto, Ont., and diagram of belt conveyors used for carrying ground and unground clay. J. W. H.

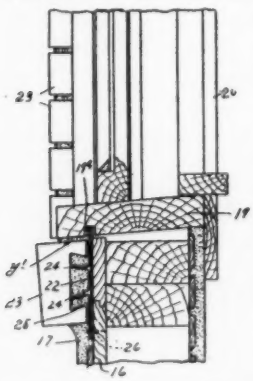
10. Construction and adjustment of dies. H. F. DINGLEDINE. *Brick and Clay Record*, **62**, 1130–1(1923).—Dies for hollow tile may be roughly divided into two classes, flat and tapered. Flat dies are never lubricated and are suitable under certain unusual conditions. Tapered dies may be lubricated with steam, oil or water. Hollow tile dies are of the tapered non-lubricated type. Angle of taper apparently is dependent upon the individual clay. To establish correct angle for a given clay, the most satis-

factory method is to start with a die having a small amt. of taper and then gradually increase the angle of taper to the point where the column speed is at a max. When this angle is passed the column speed diminishes, and when once established it is found to be fairly constant with a given clay for different shapes. However, when building dies, the angle of taper should be somewhat smaller than that found best (1) to allow for future wear (2) since no taper is better than too much taper, as a die with too much taper is more sensitive and more difficult toad just to the slight changes in clay and in tempering, (3) since the remedy involves heavy overhanging baffle plates at the back of the die which slow up the column and disturb the compactness of the clay in the side walls. Light short issue dies cause less trouble, are easier to adjust, lighter to handle and consume far less power. The raw material is the deciding factor. Hard running clays require heavy dies with strong bridges and posts and any increase in thickness of metal back of die serves as a baffle to movement of clay. After the interference back of die is reduced to a min. in shape of bridges and posts, the next step in die design is to distribute the interference as evenly as possible to permit uniform flow of clay. Cracking in drier is largely due to bridges being too close to back of die. To overcome this, move bridges back, use softer clay or serrate bottom of bridges. In dies with square corners, it is generally necessary to give areas around corners more clay, because of the great friction at corners of the die. This is accomplished by giving the die slightly more taper around the corner or slightly baffling the straight sides. J. W. H.

11. Brick-making in Czechoslovakia. RUDOLF BARTA. *Rev. Mat. Constr. Trav. Pub.*, **164,** 88B(1923).—Production amts. to 2,000 million of brick and 200 million of tile per yr. Plastic clays are mixed with sand and water in large cylinders, and then pressed moist. After drying, the brick are burned in continuous kilns of the Kohout-Hoffmann type. L. N.

PATENTS

12. Method of and means for making bricks. BERNARD F. WEBER. U. S. 1,454,826, May 8. The method of making and assembling bricks which comprises, extruding clay through a die in a parallel-sided stream, assembling slugs of a plurality of brick lengths in parallel relation to each other, and cutting the assembled parallel slugs at right angles into brick lengths.

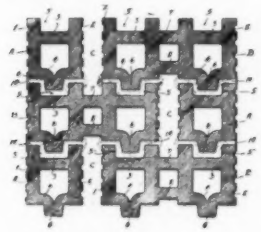


13. Brick machine. HENRY W. B. GRAHAM. U. S. 1,454,165, May 8. The combination with means for filling molds with material for making bricks, of mold return means, mechanism for inverting each mold and separating the mold and bricks, and means coöperating with said inverting and separating mechanism to turn the empty mold right side up and deliver it to said return means.

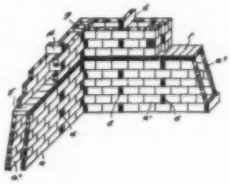
14. Brick trim for walls. MICHAEL LIPTAK. U. S. 1,454,293, May 8. The combination with a wooden wall having a wooden framed window opening of masonry-faced metallic trimming strips applied around the outer portion of said framework and interlocking therewith and secured to said wall, said wall having a stucco outer covering imbedding portions of the metallic facing strips and united with the masonry facing thereof.

15. Brick-faced metallic trim. MICHAEL LIPTAK. U. S. 1,454,294, May 8. As a new article of manufacture, a metallic base plate formed with an irregular face, cement interlocked to said base plate, and bricks held in bond by said cement and by the latter indirectly secured to said base plate.

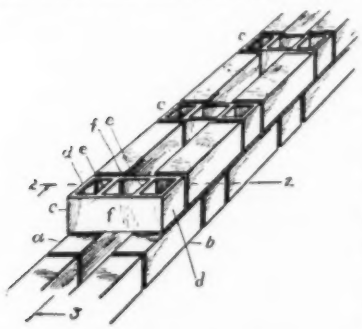
16. Building construction. LEO KROONEN. U. S. 1,451,340, Apr. 10. A wall structure combining a plurality of horizontally disposed interlocking hollow building blocks each having horizontal top and bottom walls and vertical connecting side walls extending above the top wall to form a mortar groove, the bottom wall of each block being formed with a longitudinal tongue vertically aligned with said groove and having converging side walls and positioned and embedded in mortar in the mortar groove of the adjacent block.

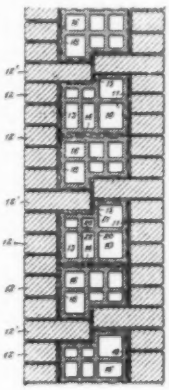


17. Hollow wall. FRITZ ECKERT. U. S. 1,451,439, Apr. 10. A hollow wall of standard bricks wherein there are interposed in the courses formed of stretchers separate bonding bricks in such a manner that the vertical course is interrupted repeatedly and the vertical shaft is shut off at these parts and several complete courses of headers laid flat dividing the whole of the hollow space into horizontal passages.



18. Wall construction. HARRY R. KREITZER. U. S. 1,456,063, May 22. A wall consisting of two parallel courses of wall members spaced apart so as to provide a space of substantial width between the courses, and transverse bonding members connecting said courses, the ends of said bonding members being supported in said courses, said bonding members being made of hollow tile consisting of longitudinal vertical webs, transverse end webs and other transverse webs intermediate the ends, the intermediate webs being supported on the inner-edge portions of said courses, thereby leaving the air space between said courses unobstructed except by the longitudinal webs of said bonding members.





19. Building block and construction. JOHN EISENMANN. U. S. 1,456,373, May 22. A backing or filling block for brick walls, said block having the full width of one bearing side formed in the same plane, and an offset in the other bearing side corresponding to half the depth of one course of the brick.

Refractories

20. Thermal capacity of bricks. F. TSCHOPLOWITV. *Brit. Clayworker*, **32**, 91 (1923).—The sp. ht. of poor conductors such as bricks may be detd. without the use of expensive calorimeters as follows: A cylindrical glass tube closed at one end, without any rim and about $1^1/_2$ in. diam. is provided with a rubber stopper about $^1/_2$ in. thick and supports a chem. thermometer, the bulb of which extends to about $^1/_2$ in. from the bottom of the tube. About 80 cc. of water is placed in the tube and the latter, with its contents, is maintained at a convenient temp., by means of a water bath. An accurately weighed amt. of material (reduced to pieces about $^1/_{12}$ in. diam is heated to 100° C. until it has attained this temp. The material is then transferred rapidly to the tube,

and the rise in the temp. of the contents is noted, the tube being kept in the water bath all the time. The temp. of the water bath is gradually increased by the addn. of hot water, so that it becomes nearly the same as the contents of the tube. The sp. ht. is then found from the following formula: $C = W(a—b)/D(e—a)$. Where C = the sp. ht., W = the wt. of water in the tube, a the highest temp. attained by the mixture, b is the temp. of the water before adding the material to be tested, D the wt. of the material, e the temp. of the hot material. Detns. made in this manner show a sp. ht. of 0.216 for fire brick and 0.184 for common brick as compared with 0.23, which figure is generally accepted. H. G. S.

21. Destruction of coke oven walls. M. PULFRICH. *Tonind. Ztg.*, **47,** 271–2 (1923).—Considerable spalling and breaking off of pieces of silica brick were observed in a coke oven wall. This trouble first occurred after the brick had been in service one year. Analyses of the brick showed that they were of high quality and that they had a softening point of cone 35. It was found that the brick was well burned and therefore this trouble could not be attributed to the expansion accompanying the transition of quartz to tridymite. The mortar which had a compn. very similar to the silica brick was next examd. and found to be composed largely of unchanged quartz which was just commencing to change to tridymite. As this change is accompanied by an increase in volume it caused the otherwise stable wall to disintegrate. The selection of a sand of the mortar which is more easily converted to tridymite is suggested as a possible means of overcoming this trouble. H. G. S.

22. Blue mountain refractories. ANON. *Min. Eng. Rec.*, **27,** 78(1923).—Tests made on the clays from the property of these refractories at Whonnock, B. C., show they carry 51.2% aluminum oxide, thus approaching bauxite. These clays are said to be the richest clays in aluminum, known to exist in Canada. O. P. R. O.

23. Preparation of pure zirconium oxide. H. VON SIEMENS AND H. ZANDER. *Wiss. Veröffentl. Siemens-Konzern*, **2,** 484–8(1922).—Brazilian zirconia (67.8% ZrO_2, 22.2% SiO_2, 8.7% Fe_2O_3, TiO_2) mixed with 25% of charcoal was heated at 1000–1200° in a stream of Cl, and the mixt. of chlorides evolved collected in a fireclay vessel. Complete reduction was not effected, only about 80% of the zirconia being reduced. There appeared to be no catalysis due to the presence of Fe and Ti. The phys. condition of the ore appears to play some part in the reduction, as slightly ignited zirconia powder is readily reduced, while powd. sintered fragments are not reduced. The mixt. of chlorides obtained is dissolved in water and the soln. evapd. to incipient crystn. The crystals of $ZrOCl_2$ thus obtained are preferably washed with a mixt. of alc. and concd. HCl in equal proportions, or alternatively, the crystals are slaked with water until completely hydrated and no further evolution of Cl occurs. The hydrated mass is dissolved in the hot alc.-HCl mixt. and the soln. crystd. by cooling. The crystals are ignited in air in order to obtain pure Zr oxide. J. S. C. I.

24. Recent electric-furnace developments. E. T. MOORE. *Blast Furnace Steel Plant*, **11,** 153–8(1923); cf. *C. A.*, **16,** 22, 686.—A total of 416 elec. furnaces had been installed or contracted for in the U. S. up to Dec. 1, 1922. There was a tendency toward the use of a greater no. of small furnaces. No appreciable interest in elec. furnaces was indicated among gray or malleable Fe foundries. An installation was made in England for melting and partly refining steel in a 10-ton furnace and then transferring approx. $^1/_3$ of the molten bath to a $3^1/_2$-ton furnace for finishing. Several elec. and metallurgical advantages are claimed. The same practice has been tried in this country with satisfactory results. The largest elec. arc furnace thus far installed is a 60-ton Greaves-Etchells furnace. This furnace has 2 charging doors on each side, 1 in the rear, and a teeming spout in the front. All doors are operated by air cylinders. Side-wall linings are 18 in. thick; roof brick 12 in. thick. There are eight 24-in. carbon

electrodes. Transformer equipment consists of four 3,000 kv. a. units, primary 4600 v., secondary 90 to 39 v. Among other developments in the general field, the need for improved electrodes has been met by at least one manufacturer by making electrodes of considerably higher density. Reports indicate better performance and less breakage with such electrodes. L. J. (*C. A.*)

25. Use of refractory materials in gas works. G. M. GILL. *Gas World*, **78**, 416–8; *Engineering*, **115**, 696–8(1923).—England possesses a considerable resource in clay which could be employed to produce semi-silica or siliceous refractory materials not having the disadvantages of either fireclay or 95% silica material. Fireclay often shows too much after-contraction and too ready a tendency to soften under load, while 95% silica material as often shows too much after-expansion, necessitating special construction, besides the extra expense of the retorts having to be built up instead of molded, and the objectionable tendency of 95% silica material to spall. There is large opportunity for the production of a much larger quantity of semi-silica or siliceous material with a SiO_2 content of 76 to 92% according to the position in the setting and the purpose for which it is required. The same class of material might also be used with great advantage for producer arches and walls and for the crowns of the arches in horizontal settings. At least 75% of the material required for building modern retort settings should be of a quality showing not more than 1% max. expansion or contraction at 1350° to 1400° under load, the remaining 25% showing not more than 1% max. expansion or contraction at 1280° under load. J. L. W. (*C. A.*)

26. Comparison of the modulus of rupture of silica bricks, hot and cold. E. C. MCGREE. *Rev. universelle mines*, **17**, 36–7(1923).—The modulus of rupture (under pressure) at 1350° was approx. $^1/_3$ that at ordinary temp. The decrease in transverse resistance to rupture was approx. inversely proportional to increase in temp. and it is possible to est. the modulus of any brick at high temps. from its value at ordinary temp. Very rapid heating to a red heat reduced the modulus disproportionately. C. C. D. (*C. A.*)

27. Physical chemistry of refractory oxides. OLAF ANDERSEN. *Norg. Geol. Undersökelse*, **1**, 55 pp.(1922).—Summary of recent high-temp. investigations of single refractory oxides and of systems contg. several of these oxides as components. A bibliography is given. J. A. A. (*C. A.*)

28. Norwegian dolomite. Utilization of dolomite. OLAF HOLTEDAHL AND OLAF ANDERSEN. *Norg. Geol. Undersökelse*, **2**, 49 pp.(1922).—Deposits of fine-grained dolomite occurring in the northern part of Norway are described. Some preliminary expts. on the "burning" of dolomite have been carried out. The heating of this dolomite for 2–5 hrs. at 1400° produced no effective sintering. The structure of the raw dolomite has no great influence on the structure of the burned product, since, within certain limits, the resulting lime and magnesia were always very fine-grained. The sepn. of lime from raw dolomite by elec. sintering or melting is discussed. J. A. A. (*C. A.*)

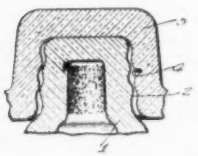
Whiteware

29. The production of porcelain for electrical insulation. F. H. RIDDLE. *J. Am. Inst. Elec. Eng.*, **42**, 343–6, 540–3(1923).—A history of elec. porcelain. It is defined as "an agglomerate of clay and quartz held together in a matrix of molten feldspar." Some typical analyses of the clays used are given. The phys. properties and functions of the raw materials are reviewed. W. E. R. (*C. A.*)

PATENT

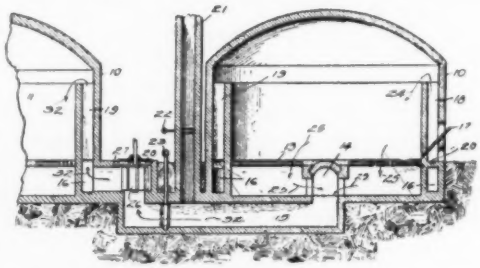
30. Talc porcelain. KÔSUKE HIRANO. Japan. 40,863, Nov. 30, 1921. A mixt. of 25% talc, 30% talc previously fired at about 1200°, 30% clay or kaolin, 10% feldspar

and 5% magnesite, previously fired at 600–1200°, is used. Only one process of heating is sufficient. The addn. of magnesite is specially emphasized. (*C. A.*)



31. Joint for articles of ceramic and similar materials and method of producing same. ARTHUR O. AUSTIN. U. S. 1,456,960, May 29. In combination, a plurality of ceramic bodies having connection with one another at a plurality of points of limited extent, said bodies being fused to one another at their points of connection to provide a yielding joint. See also *Ceram. Abs.*, **2**,77(1923).

32. System of kilns. LEROY WEEKS. U. S. 1,454,358, May 8. A battery of kilns each provided with heating chambers and passageways arranged between the heating chambers and connected together by a subterranean conduit, each of said conduits having an opening in the top wall thereof, a fan element arranged to be selectively and removably received in any one of the conduits between any pair of kilns, so that heated air from one kiln may be drawn into the next adjacent kiln, a bearing member for said fan element arranged to be seated in any of said openings, and when the kiln is at a predetermined heat the fan element and bearing member may be removed for the purposes stated.



33. Insulator. WALTER T. GODDARD. U. S. 1,454,634, May 8. An insulating unit comprising an element formed of frangible insulating material, a rigid metallic element connected thereto, and means for connecting said elements at a plurality of points and for equalizing the strains imparted from one of said elements to the other, said means involving a continuous flexible sinuous member alternately engaging the said connected elements at a succession of points on each of said elements.

34. Porcelain tank and process of making the same. CHARLES J. KIRK AND GEORGE BRAIN. U. S. 1,449,761, Mar. 27. The process of casting porcelain tanks having corners that comprises pouring liquid slip into a suitable mold, permitting the porcelain to set until the side walls of the tank have solidified, piercing one or more of the corners to permit the escape of unsolidified slip and draining off the unsolidified slip.

35. Process and mold for forming earthenware articles and product thereof. CHARLES J. KIRK AND GEORGE BRAIN. U. S. 1,449,762, Mar. 27. The process of forming a closet of cast earthenware which comprises providing a siphon member forming the top of the discharge arm of the siphon and the bottom of the intake arm of the siphon, the said member having the intake siphon portion supported throughout its length upon said discharge portion by means of a solid web, placing the said siphon member in a mold, forming the exterior of the closet bowl, and casting the said siphon member within the closet.

36. Nonslip tile. ABRAHAM ALBERT KLEIN AND MILTON F. BEECHER. U. S. 1,451,462, Apr. 10. A non-slip tile comprising wear-resisting abrasive granular material of a hardness between quartz and crystalline alumina and a ceramic bonding material integrally united by heat into an abrasive, wear-resisting and substantially integral mass in which the granular material constitutes a substantial proportion of the surface

of the tile and the bond is capable of permitting renewal of the safety characteristics of the tread surface.

Equipment and Apparatus

37. A new form of precision hydrometer. C. W. FOULK. *J. Optical Soc. Am.*, **7**, 327–34(1923).—The principle of the app. is that of submerged floating equil., in which an elongated hollow glass or silica bulb is ballasted so that it neither rises nor sinks in a given liquid. One type of app. consists of a tube open at both ends and of the right diam. to allow the float to move freely along its length, the appropriate scale being etched on the side wall of the tube. To the bottom of the float is attached a small chain hanging in a catenary curve between the float and an independent pt. of support. When the app. is put into a liquid the float takes up a position detd. by the d. of the liquid while the suspended chain automatically adjusts the wt. to that d. The effect of various consts. of the above float on response to differences of liquid d. is shown by the equation: $\Delta d = w[(D—d) \times \Delta b]/(2D \times V)$, in which Δd = density change in liquid causing vertical displacement of float of Δb measured in cm., D = density of chain material, d = density of liquid, V = vol. of float in cc. and w = wt. in g. of 2 cm. of chain. The formula shows the sensitiveness of the instrument to be proportional to the vol. of the float and inversely proportional to the wt. of a unit length of chain. Advantages over old types are: more accurate scale reading, absence of troublesome surface phenomena and uniform temp. Some disadvantages are given. H. E. B. (*C. A.*)

38. The improved MacMichael viscosimeter. W. H. HERSCHEL. *J. Optical Soc. Am.*, **7**, 335–53(1923).—The app. is a const.-deflection, torsional instrument, with advantage of speed of operation, and weakness due to variations in torsional resistance of suspending wire. It consists of a torsional pendulum with a bob hanging in the liquid to be tested. On a turntable is an outer cup concentric with the cup holding the test liquid, and the space between contains oil or H_2O with an elec. resistance coil for heating. The turntable moves at const. speed and the pendulum has const. deflection during the test, due to the viscous drag of the liquid. The deflection is read on a horizontal dial concentric with the bob by means of a telescope, and the circumference is divided into 300 equal parts, called the MacMichael degrees. Two bobs are supplied, one similar to the disk formerly used and the other a cylinder 1 cm. in diam. and 4 cm. high. Various methods are described for avoiding end effects, including the use of guard rings on the inner suspended cylinder and trapping of an air bubble under the bob. Turbulence is caused by too wide a clearance and an equation is given for estg. the crit. velocity at which it begins. Imperfect elasticity of the torsional wire is the cause of considerable error and several tables are given showing allowable deflections and variation in torsional modulus of elasticity with diam. of wire. Tables and equations are also given to show the measurement of turning moments on the suspended wires, the variation of dial readings with change of viscosity and wire diam., and detn. of deflection by mirror and scale method. The conclusions reached are, that the wires of the improved MacMichael viscosimeter cannot be calibrated with H_2O because of turbulence, a liquid with viscosity of about 0.5 poise being required. The end effects are negligible compared to errors due to semi-permanent set of the torsion wires. The app. might be greatly improved by measuring the moment due to viscous drag by other means than the torsion wire. H. E. B. (*C. A.*)

39. Viscosimeter. E. STERN. *Chem.-Ztg.*, **47**, 291–2(1923).—The app. is useful in comparison work on *colloids*, such as *varnishes*, solns. of *cellulose*, *rubber adhesives*, etc., as well as in the *oil* industry. It consists of 3 cylindrical glass bulbs, the middle one contg. 75 cc. between marks on the stems joining it to the others. The upper bulb is open at the top while the lower terminates in a tube to which capillary tubes of different

lengths and diams. may be attached in order to change the rate of discharge. A H_2O-jacket is provided for work at const. temp. J. H. M. (*C. A.*)

40. A laboratory optical pyrometer: notes on its design and operation. WM. SCHRIEVER. *Proc. Iowa Acad. Sci.*, **28**, 69–82(1921).—An optical pyrometer suitable for accurate temp. detns. and flexible enough to be of general use in a physical lab. is described with illustrations. A brief sketch of the theory and design of a Holborn-Kurlbaum optical pyrometer is included (cf. *C. A.* **16**, 4097). W. G. G. (*C. A.*)

41. A thermoelement for radiation measurements. RUDOLF HASE. *Z. Physik.*, **15**, 52–3(1923).—A short piece of an alloy which will give a very high thermoelec. force is welded to suitable leads and placed in a thin-walled, highly evacuated glass bulb. The black collecting disk is fastened to the "hot junction" and the cold junction is in the shadow of the disk. A novel mounting of the thermoelement and galvanometer cuts out all extraneous radiation and the scale, which is calibrated to read the black-body temp. directly, is illuminated by the radiating body. The instrument is suitable for measuring all temps. above 500°. C. C. V. V. (*C. A.*)

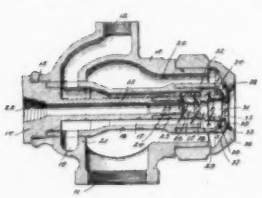
42. Laboratory apparatus for heating at high temperatures. GEORGES CHAUDRON AND M. GARVIN. *Chimie et industrie*, **9**, 647–50(1923).—Brief description of the Tammann, Arsen, and Ruff furnaces. C. and G. designed a vacuum furnace for high temps., consisting essentially in a double-walled metal body in 3 sections: base, contg. suction, gas, electricity and water connections; body proper and cover. Water can be circulated through the 3 portions. Heating is obtained by means of an internally wound W coil, which can be heated 8 times up to 2000° before wearing out. A vacuum of 0.001 mm. can be obtained cold and 0.02 mm. hot. An app. for winding the W coils is described. A. P. C. (*C. A.*)

43. Improvement in crusher steel is suggested by metallographic tests. O. E. HARDER. *Eng. Mining J. Press*, **115**, 314–8(1923).—Examn. of failures of mine and mill equipment indicates that sufficient attention is not given to heat-treatment in the process of manuf. V. O. H. (*C. A.*)

44. Safety locking device for filter press. W. J. TAIT. *Eng. Mining J.-Press*, **115**, 938(1923).—An illustrated description of a device to prevent opening of a filter press head while under internal pressure. It consists of a diaphragm and plunger operating 2 safety catches held down over the locking yoke. C. C. D. (*C. A.*)

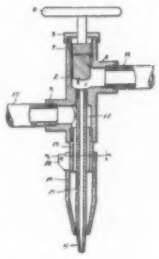
PATENTS

45. Burner. ALFRED R. ANTHONY. U. S. 1,451,063, Apr. 10. An oil burner including in combination, a body, a fuel tube therein said tube having a chamber at its forward end open at the tip of the tube and said tube also having an aperture for discharging a jet into said chamber, the wall of the fuel tube surrounding the chamber having a plurality of series of holes therethrough spaced along the length of the chamber, each series comprising a plurality of holes spaced circumferentially of the wall one series being inclined forwardly toward the axis of the chamber and one series being inclined in a circumferential direction to discharge the air into the chamber with a whirling motion.

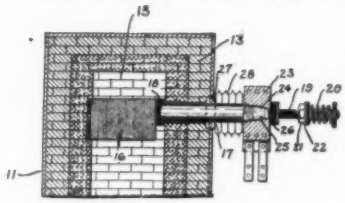


46. Oil burner. FRANK J. ATKINS. U. S. 1,452,020, Apr. 17. In a burner of the class described, a tubular main body provided with a pair of lateral extensions at opposite sides thereof communicating with its interior, said body having an enlarged chamber at its rear, a valve seated in said chamber, a cap threaded on the valved end of said body, an oil tube extending forwardly and threaded into the burner body and in communication with said chamber, said tube being contracted at its outer end to form a

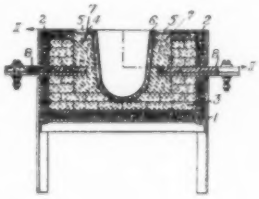
nozzle, said body having an enlarged chamber in front of the connection with the oil tube with the body, said chamber being cut off from communication with the first mentioned chamber and from the tube, a tubular connecting sleeve threaded into the front end of the second mentioned chamber and encircling the oil nozzle tube, the bore of said connecting member being a larger diameter than the tube providing a chamber communicating with the second mentioned chamber, and a tubular air nozzle adjustably secured around and encircling the oil nozzle tube, said air nozzle being contracted at its front end adjacent the base or inner end of the contracted portion of the oil nozzle, the air nozzle being adjustably mounted on the sleeve connection whereby the outlet end of the air nozzle will at all times be positioned at the rear of the outer end of the oil nozzle.

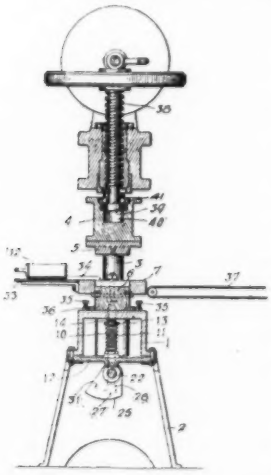


47. Terminal for electric furnaces. PORTER H. BRACE. U. S. 1,456,865. In an electric-resistance furnace, the combination with a movable electrode and a stationary water-cooled collar surrounding said electrode, of a movable water-cooled terminal secured to one end of said electrode and an expansible metal tubular member secured to said collar and said terminal for preventing the escape of a heated fluid leaking past said collar and for equalizing the temperatures of said collar and said terminal.



48. Electric furnace. CRANSTON H. CARPENTER. U. S. 1,444,948. In an elec. furnace, the combination with a refractory casing, of a muffle of refractory electrical-conducting material in said casing, hoppers in said casing on opposite sides of said muffle, solid carbonaceous terminal electrodes extending into said hoppers, and a mass of electrical-conducting granular material in each of said hoppers adapted to electrically connect said electrodes and said muffle and to permit the current to traverse the walls of said muffle, said masses of granular material being in contact with said muffle over a relatively small portion of its surface.





49. Power tile press. EDMUND W. ZEH. U. S. 1,456,752, May 29. In a power tile press, the combination of a lower die to receive the material of which the tile is to be formed, an upper die adapted to coöperate with said lower die to compress the material, operating means for moving the upper die into and out of contact with material in the lower die, and means for enabling successive percutient blows to be struck upon the material while the dies are in contact therewith.

50. Crushing machine. GEORGE HOLT FRASER. U. S. 1,451,149, Apr. 10. In combination, an annular die revolving in an approximately vertical plane and having an internal crushing face, a movable and rotatable crushing roll within and eccentric of said die and having a peripheral crushing face reciprocal to the inner face of said die, means for revolving one of said parts, a

casing supporting said parts, a movable member movably mounted on said casing, non-rotative movable means on which said roll is rotatably mounted and movably mounted on and held outwardly by said movable member, and pressing means opposite and reacting on said movable member and said casing for holding said non-rotative means outwardly to hold said roll outwardly toward the inner face of said die to resist a crushing pressure therefrom.

51. Machine for crushing or grinding. GEORGE H. FRASER. U. S. 1,451,150, Apr. 10.

52. Machine for crushing or grinding. GEORGE H. FRASER. U. S. 1,451,151, Apr. 10.

53. Pulverizing mill. GEORGE H. FRASER. U. S. 1,451,152, Apr. 10.

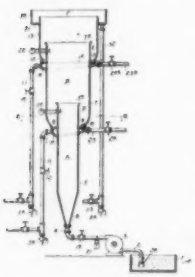
54. Pulverizing mill. GEORGE H. FRASER. U. S. 1,451,153, Apr. 10.

55. Machine for grinding and crushing. GEORGE H. FRASER. U. S. 1,451,154, Apr. 10.

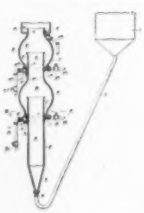
56. Machine for crushing or grinding. GEORGE H. FRASER. U. S. 1,451,155, Apr. 10.

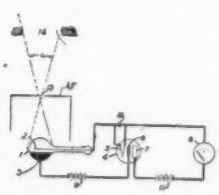
57. Machine for crushing and grinding. GEORGE H. FRASER. U. S. 1,451,156, Apr. 10.

58. Method of separating granular solid materials. MARTIN HOKANSON. U. S. 1,449,603, Mar. 27. The method of separating solid materials of different specific gravities or sizes, which consists in subjecting the material to an upwardly flowing stream of water of such diameter relative to its velocity as to cause the heavier particles to move radially to the outside of the stream and the lighter particles to remain inwardly thereof, continuing such flow until the particles of a given grade have moved to the outside of the stream, and continuously withdrawing such material and water uniformly around the stream.



59. Apparatus for separating solid materials of different specific gravities. MARTIN HOKANSON. U. S. 1,449,604, Mar. 27. Apparatus for separating solid granular materials, comprising a vertical vessel, means for forcing the materials in a finely divided form mixed with water upwardly through said vessel, said vessel intermediate its height being provided with a portion of increasing diameter providing an annular chamber in which the solids are deposited by radial separation from the vertical stream, said annular enlargement being provided with a series of outlets uniformly spaced around said vessel, an annular chamber receiving from said discharge openings, said annular chamber being of progressively increasing dimensions from one side, and a controllable outlet from the largest point of said drawn-off chamber.

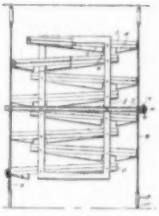




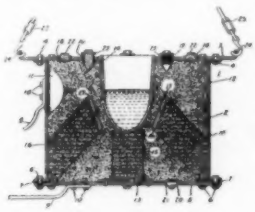
60. High-temperature measurement. HERBERT E. IVES. U. S. 1,449,512. A device for measuring the temperature of a highly heated body comprising a photo-electric cell for translating radiant energy into electrical energy, a perforated diaphragm at a fixed distance between said cell and the highly heated body, the perforation in said diaphragm subtending a solid angle from all parts of the cell smaller than that subtended by the highly heated body, a vacuum tube for amplifying the current of said electrical energy, and means for registering the amplified current.

61. High-frequency screen. HARRY H. KELLER. U. S. 1,446,298, Feb. 20. A multiple deck screen, a tensioned supporting means arranged for unitary action and

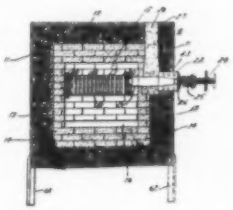
a disturbing force for said means to cause the screen to move as a unit with a true rectilinear motion.



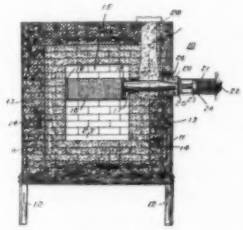
62. Electric resistance furnace. GEORGE M. LITTLE. U. S. 1,456,890, May 29. An elec. fur. comprising a metal container, a metal cover for said container, a metal base plate secured to and insulated from said container, means for attaching elec. supply circuit terminals to said container, granular resistor material surrounding said crucible and means in said cover for compressing said resistor material in said container.



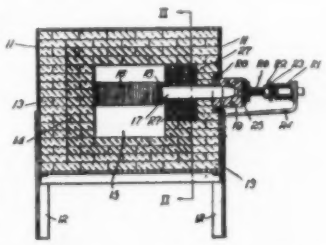
63. Electric furnace resistor. GEORGE M. LITTLE. U. S. 1,456,891, May 29. An elec.-resistance fur. comprising a built-up resistor consisting of single flat carbonaceous plates of relatively large area of cross-section alternating consecutively with a plurality of flat carbonaceous plates of relatively small area of cross section, the area of cross-section of the small plates being in accordance with the kw. input of the fur.

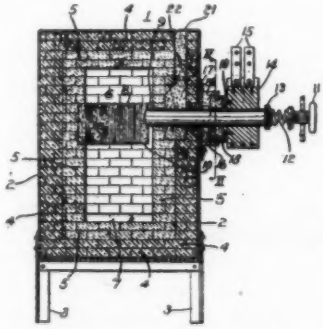


64. Protected electrode for electric furnaces. GEORGE M. LITTLE. U. S. 1,456,892, May 29. An electric furnace comprising a plurality of furnace walls, an electrode extending horizontally through one of said walls and movable relatively thereto during operation of the furnace, a well in said wall, a quickly renewable granular oxidizable barrier in said wall surrounding said electrode over a portion of its length intermediate its ends, said barrier being adapted to prevent chemical action of entering air upon said electrode but permitting free movement of said electrode relatively to said wall.



65. Electric-furnace wall construction. GEORGE M. LITTLE. U. S. 1,456,893, May 29. An electric furnace comprising a plurality of walls enclosing a furnace chamber, a resistor located in said chamber and supported at one end thereof by one of said walls, a plurality of electrodes operatively engaging said resistor to conduct current to and from said resistor, and means for reducing the current leakage between and from said electrodes said means comprising a plurality of spaced-apart refractory members surrounding said electrodes intermediate their ends and having only a relatively small area of surface contact between adjacent plates.

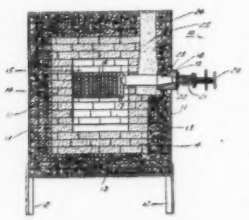




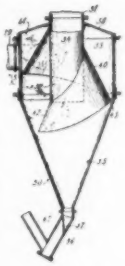
66. Telescoping electrode protector. GEORGE M. LITTLE. U. S. 1,456,894, May 29. An electric furnace comprising a plurality of furnace walls enclosing a furnace chamber, a resistor in said chamber, a carbonaceous electrode extending through one of said walls

for conducting current to and from said resistor and having limited longitudinal movement relatively to said wall, a water-cooled terminal mounted on said electrode at its outer end, granular oxidizable material surrounding said electrode between said wall and said terminal and a two part telescoping container for said granular material, one part being secured to said wall and the other part being located against said terminal.

67. Electric-furnace resistor. ORA A. COLBY. U. S. 1,448,388, Mar. 13. In an elec. fur., the combination with a plurality of walls surrounding a fur. chamber, of a resistor in said chamber comprising a plurality of dished refractory elec.-conducting members, granular resistor material in each of said dished refractory members and resilient means for maintaining said dished members in interlocked position in said furnace chamber free of said walls.

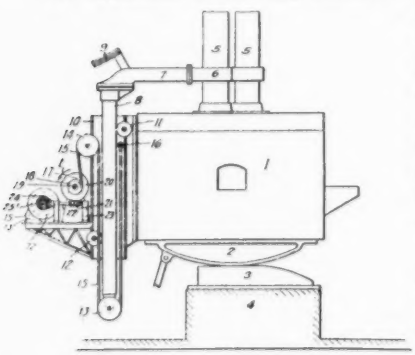


68. Separator. HARRY RAYMOND COLLINS. U. S. 1,444,585, Feb. 6. A separator comprising a cylindrical casing provided near its upper end with a port through which a current of air laden with material may enter the separator and at its lower end with a discharge chute, a cylindrical relief pipe within the casing, and a downwardly flaring spiral member attached to the relief pipe along a line of progressively varying pitch to provide a spiral chamber of gradually increasing volume above the member.

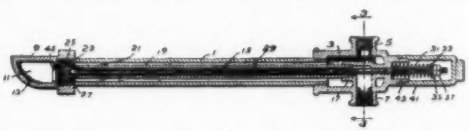


69. Method of making anhydrous magnesium chloride. PAUL COTTRINGER AND WILLIAM R. COLLINGS. U. S. 1,450,912, Apr. 10. The method of making anhydrous magnesium chloride which consists in causing a reaction between magnesium oxide and hydrochloric acid gas, substantially as described.

70. Apparatus for moving furnace electrodes. WALDEMAR DYRSSEN. U. S. 1,450,668, Apr. 3. An elec. fur. having a movable electrode, a motor rotating continuously in one direction at a substantially constant speed, a shaft connected by differential gearing to said motor for moving said electrode, and means operatively connected with said differential gearing for controlling the rate of rotation of said shaft.

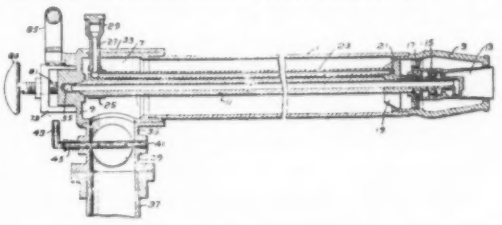


71. Liquid-fuel burner. MILTON A. FESLER. U. S. 1,445,826, Feb. 20. A liquid fuel burner, comprising, in combination, a steam conducting tube, an oil conducting tube mounted in said steam conducting tube, a delivery head communicating with said tubes, a single valve for automatically controlling the discharge of steam and oil from said tubes into said head, a stem for said valve projecting through the oil conducting tube, and a coil spring coöperating with said stem to close said valve, but yieldable in response to steam pressure on the valve to allow the latter to open.

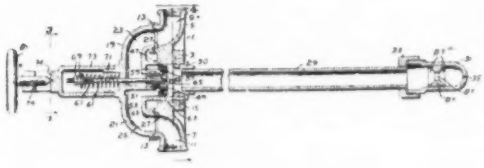


72. Burner. MILTON A. FESLER. U. S. 1,445,827, Feb. 20. The combination

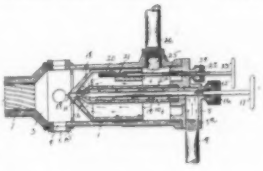
with a support, of a burner movably mounted thereon and having fuel and fluid conducting passages leading to the delivery end of said burner, and a device adapted to lock the burner in the support and to admit fuel to the burner when in one position and adapted to unlock the burner from the support, to cut off the fuel supply and to admit fluid to the fuel passage to drive residual fuel therefrom when in a different position.

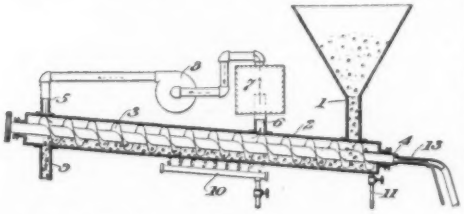


73. Burner. MILTON A. FESLER. U. S. 1,445,828, Feb. 20. In a fuel oil burner, the combination of a casing provided with a delivery office, a mixing chamber located remotely from said orifice, a long conduit extending from said chamber to said orifice, and oil and steam passages leading to said mixing chamber; a valve seat adjacent the delivery ends of the oil and steam passages, and a spring-pressed valve for closing both said passages.

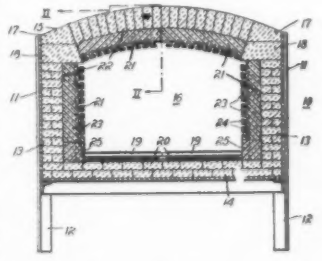


74. Fluid-fuel burner. PAUL B. NORRIS. U. S. 1,446,514, Feb. 27. In a fluid fuel burner, the combination of a body; an atomizing nozzle slidingly mounted in the body and having a nozzle opening with a tapered interior wall extending therefrom; a screw operating in the atomizing nozzle; a stem on the screw locked against axial movement relatively to the body, the screw being adapted to adjust the atomizing nozzle axially of the body; and a contracted fuel nozzle discharging into the atomizing nozzle, said fuel nozzle being placed to the rear of and in alignment with the atomizing nozzle.



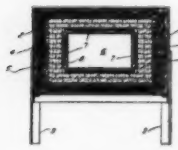


75. Process of and apparatus for heating materials. CHARLES J. REED. U. S. 1,447,888, Mar. 16. In an app. for the heat-treatment of solid material an inclined tubular chamber, one portion of which is maintained at a higher temperature than other portions, in combination with means for causing the solid material to move through the chamber in a specific direction from a lower to a higher level into and out of the heated portion, and means for simultaneously causing mobile material to move through the chamber in the opposite direction.

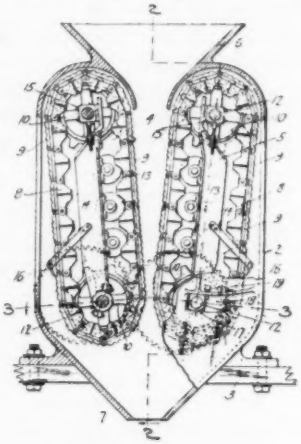


76. Electric furnace. THOMAS A. REID. U. S. 1,444,939, Feb. 13. An elec. heating element for a fur. chamber defined by refractory walls comprising a plurality of spaced-apart relatively narrow, elongated refractory members extending beyond the inner surface of said walls into said chamber each having a plurality of spaced apart transversely extending slots of substantially L-shape adjacent to

the inner surface thereof, and a plurality of end-connected convolutions of relatively heavy and selfsupporting-resistor material located in said slots and extending openly between said refractory members.

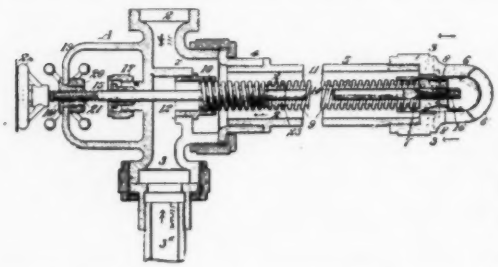


77. Resistor-supporting means. THOMAS A. REID. U. S. 1,444,940, Feb. 13. An elec. resistor supporting means comprising a refractory member having a plurality of rows of relatively small recesses in one surface thereof, the recesses being operatively aligned in two directions.



78. Crushing and grinding machine. JAMES A. WARREN. U. S. 1,448,013, Mar. 16. A crushing and grinding machine comprising a pair of downwardly converging endless belts one of which is mounted to swing outwardly with relation to the other, and means to yieldingly hold the movable belt in its normal position.

79. Burner. CARLYLE J. SHERWOOD. U. S. 1,455,175, May 15. In a device of the character described, a casing, a corrugated tube within said casing, means for securing one end of the tube, means for delivering a liquid under pressure to the interior of the tube, and means for delivering a separate liquid under pressure to the casing, and a valve member secured to the end of the tube operable for simultaneously decreasing or increasing the flow of a liquid from the tube and casing.



Kilns, Furnaces, Fuels and Combustion

80. Ceramic furnaces. Forced draught versus natural draught. ANON. *Brit. Clayworker*, **32**, 71(1923).—Forced vs. natural draught in ceramic fur. was the subject of discussion (May 14) at the Technical congress of the ceramic industry held in Paris. M. Denisse discussed the advantages and disadvantages of the various furnaces and compared the tunnel and continuous ovens, and showed that the use of the fan increased production by 25%. He concluded that a fan, whether employed for drying or for firing, was a valuable aid to the ceramic industry. M. Norray defended the natural draught, in particular he claimed that the use of forced draught was useless in connection with Hoffman ovens, and that it would be wrong to use it in every case. M. Granger, chief of the Testing Laboratory of the Sévres porcelain factory, described improvements in the manuf. of plates, and gave an account of modern plant processes.

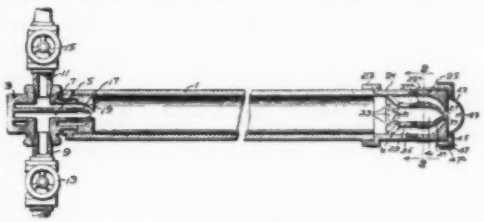
O. P. R. O.

81. Surface combustion with special reference to recent developments in radiophragm heating. W. A. BONE. *Gas J.*, **162**, 423–8(1923); *Gas World*, **78**, 405–9; cf. *C. A.*, **8**, 3358; **16**, 2021.—It has been proved previously that: According to their chem. nature and physical texture all hot surfaces, at temps. below ignition point, have the power of accelerating gaseous combustion in different degrees; at high temps. this difference in power of acceleration practically disappears; during combustion the chem.

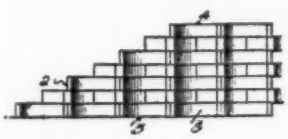
action occurs mainly in, and is usually confined to, the boundary layers between the gaseous and solid phases; the accelerating influence rapidly increases with rise in temp.; and all surface combustion depends upon the absorption of the combustible gas, and probably the O by the surface, thereby becoming activated through assoc. with the surface. These discoveries were applied to industrial purposes and in particular to an installation of 2 boilers at the Skinningrove Iron Works fired on this principle with coke-oven gas (cf. *C. A.* **8,** 1863). A radiophragm was devised which consisted of a porous diaphragm of refractory material through which was forced a homogeneous mixt. of gas and air in the right proportions for complete combustion. This mixt. was burned at the front face of the diaphragm without flame, and maintained the surface there in a state of incandescence. Unfortunately, the radiophragm proved difficult to manuf. and possessed the disadvantage of pre-ignition when working at a temp. above 900°. Recent improvements have been made which have entirely eliminated this risk of backfiring even at much higher temps. The new radiophragms are being made in both flat and circular forms and are finding a wide variety of industrial applications, such as baking, cooking, metal-melting, water-heating, etc. The great advantage lies in the possibility of consuming large vols. of gas within a very limited space with the attainment of very high temps. and without the use of regenerators of a waste of gas. J. L. W. (*C. A.*)

PATENTS

82. Burner. FRANCIS H. BROWN. U. S. 1,451,812, Apr. 17. A burner comprising in combination, a body having a delivery tip provided with an orifice, means for conducting the oil and atomizing fluid to the body and for atomizing the oil as it is delivered to the body, and a secondary atomizing means located within the body between the first atomizing means and said tip and comprising a pair of adjustable nozzles one within the other.



83. Brick or tile for furnace construction. CHARLES F. BINNS. U. S. 1,456,498, May 29. An article of manufacture comprising a brick for wall construction, said brick having flat top and bottom faces coextensive with the length and breadth of the brick and parallel aligned end faces, and a laterally offset portion intermediate of the end faces.



Geology

84. Titanium. Canada. A. H. A. ROBINSON. Can. Dept. of Mines, *Rept.*, (1922).—A very useful and complete report of 119 pages on "Titanium" discusses the manuf. properties and uses of this pigment, as well as those of other useful titanium compounds and describes in detail the occurrence in Canada of large unexploited deposits of titanium ores that may in future become of great industrial importance.
O. P. R. O.

85. Magnesite deposits of Grenville, Quebec. G. W. BAIN. *Trans. Am. Inst. Mining Met. Eng.*, No. **1244M,** 19 pp.(1923).—Magnesite and dolomite, both mineral and rock, occur in the Grenville limestone associated with gneisses and dikes. The deposits are found only beneath impervious dikes and on or near the crests of anticlines. They were probably formed by replacement, by means of hot Mg-bearing waters from a granite magma. E. F. H. (*C. A.*)

86. Report on Texas alkali lakes. C. C. MEIGS, H. P. BASSETT AND G. B. SLAUGH-

TER. Univ. of Texas, *Bull.*, No. **2234,** 59 pp.(1922).—Other K deposits of the country are critically reviewed. The brines described are in Lynn, Terry, Hockley, Lamb, Bailey and Cochram Cos. The "lakes" are depressions formed by the removal, by soln., of salt beds from underlying Permian beds. They are filled with silt containing brine and salt crystals, fed by springs coming from the Permian strata. Salt, K, and Mg are the valuable constituents of the brines. A large number of analyses and logs of wells are given. Much of the paper consists of recommendations for the process to be used, and cost ests. E. F. H. (*C. A.*)

Chemistry and Physics

87. Vapor pressure of arsenic. Determination of the vapor pressure of metallic arsenic. SHINKICHI HOSIBA. *Konin Klijke Akad. Van Wetenschappen Amsterdam Proceedings,* **25,** 387–94(1923).—The vapor pressure of gray arsenic in the solid and liquid phases was detd. and the data given in tabular form. The m. p. of gray arsenic is given as 817–18° at a pressure of 35.8 atm. W. M. C.

88. French potash industry. M. MENNECKE. *Chem. Age.,* **8,** 672.—The Alsatian potash deposit consists exclusively of silvinite, (KCl and NaCl), or mineral salt. The method of extraction is by drilling and the use of explosives. The raw salts are delivered for agricultural purposes or are refined in the chem. works to 80 or 98% muriate of potash and used for the manuf. of sulphate of potash. O. P. R. O.

89. Plasticity of ceramic materials. BIGOT. *Brit. Clayworker,* **32,** 71(1923).—The plasticity of ceramic materials was considered by Dr. Bigot at the Technical congress of the ceramic industry, Paris, May 15; he said that colloidal plasticity was of vital importance in ceramics, he described methods of measuring it, the variations it underwent during pressure and firing, and pointed out that processes of rapid manufacture should be preceded by lab. studies on plasticity. O. P. R. O.

90. Ceramic products: degree of firing ascertained by microscope. L. BERTRAND. *Brit. Clayworker,* **32,** 71(1923).—The compn. and structure of various claps and the change they undergo on heating, was discussed by L. Bertrand, of the École Normale Supérieure, at the Technical congress of the ceramic industry, Paris, May 15. Methods of microscopical examn. were described, and it was shown how these could be used to give results with a precision unobtainable by chem. analysis; for instance, a microscope made it possible to ascertain the degree of firing of certain delicate ceramic products. O. P. R. O.

91. Tantalum and its technical uses. S. L. MALOWAN. *Edel Erden u. Erze,* **4,** 26–8(1923).—After a brief history of the discovery and first isolation of the metal, the method of reduction and uses are given. The high m. p. of Ta makes it adaptable for light bulbs in place of W; the life of these lamps is about 1,000 hrs. The metal is also used for instruments in the medical and dental professions because of its hardness and resistance to common acids. W. A. M. (*C. A.*)

92. Calcium aluminium silicate and zeolite question. ST. REINER. *Zement,* **12,** 49–51, 55–7, 65–6(1923).—A review and criticism of previous work on zeolites. R. F. S. (*C. A.*)

93. The constitution of the silicates. G. TAMMANN. *Z. anorg. allgem. Chem.,* **125,** 301–6(1922).—T. finds that the mol. sp. heats of the silicates are additive, and concludes that the mols. are independent and at temps. far removed from their m. p. do not vibrate appreciably. This conclusion is supported by the fact that only in the neighborhood of the m. p. do isomorphous complex substances diffuse into one another visibly. In soln., silicates undergo hydrolysis, and this therefore gives no definite information as to the mols. which exist in the solid. The structure of molten silicates cannot be investigated. The complex silicates differ from the C compds. in that they are decomposed in soln. and in the fused state, and the mol. theory of org. chemistry finds no application in the chemistry of silicates. J. C. S.

94. A practical procedure for the analysis of bauxite. G. CASTELLI. *Rass. min. met. chim.*, **58,** 62–5(1923).—The standard procedure of English metallurgical labs. for detg. H_2O, ignition loss, SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, K_2O, Na_2O, P and S is given with typical *analyses of bauxite* from several countries. C. C. D. (*C. A.*)

95. High-temperature investigation. E. F. NORTHRUP. *J. Franklin Inst.*, **195,** 665–86(1923).—A comprehensive account is given of the methods and technic used in the study of matter at high temp. free from chem. contamination, with special reference to the *high-frequency induction furnace.* J. S. H. (*C. A.*)

96. Rapid technical estimation of iron oxide and alumina in clays and in their products. FERNANDO LUCCHESI. *Giorn. chim. ind. applicata*, **5,** 12–4(1922).—Carefully wash the fresh ppt. of the hydroxides of Fe and Al obtained in the usual way until no more chlorides are found in the filtrate. Place filter and contents in a beaker and add from a buret a known excess of 0.5 *N* H_2SO_4 (50 cc. of the acid for each g. material taken for analysis). Boil for about 10 min. Cool, add 2 drops of 0.02% Me orange, and titrate with 0.5 *N* NaOH until the red hue disappears. (Use for comparison an equal vol. of acidulated H_2O colored with 2 drops of Me orange.) Do not continue toward the yellow, but stop at the point of change. Calc. by difference the acid combined with the 2 oxides. Add to the soln. 1 cc. concd. H_2SO_4, reduce with H_2S and in the same beaker est. the Fe with 0.1 *N* $KMnO_4$. The filter paper present does not appreciably affect the results, which are satisfactory, with the advantage of very rapid execution. R. S. P. (*C. A.*)

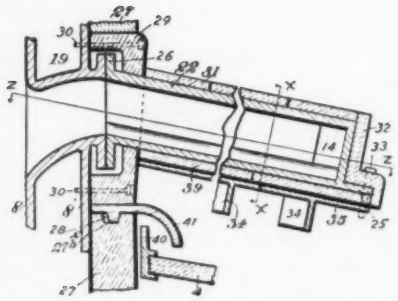
97. Laws of crushing. J. HERMAN. *Eng. Mining J. Press*, **115,** 498–9(1923).—Tests on a wide variety of materials, with a screen discharge ball mill, are presented as curves; energy input *vs.* mesh of product with *Kick's* and *Rittinger's* laws are also shown graphically for comparison. The results are more in accord with Rittinger's law, particularly when the grinding is efficiently done. This law represents the min. power required, Kick's the max. Results on tough materials approach the latter law especially when the reduction ratio is small. The error in applying Kick's law to crushing lies in assuming immediate release of pressure after initial fracture and in failing to consider the energy remaining after this initial fracture which does further crushing work. Rittinger's law also applies to sawing, planing, filing, boring, chiseling, scouring, peeling and gouging. C. C. H. (*C. A.*)

General

98. Oil fuel for clay drying. ANON. *Chem. Age*, (China Clay Trade Rev. Sec.), **8,** 10(1923).—An interesting, illustrated article dealing with a new method of drying clay, giving an account of the expts. carried out for over 6 months with Shell-Mex oil fuel at Great Hallaze China Clay Co. dry at Par, Cornwall. The drying capacity with oil fuel is 156% over that of coal, and the drying cost 93 d. per T. of clay dried compared with 102.58 d. in the case of coal. The clay can be placed on the pan in a very much thinner condition and can be dried very much more quickly without in any way affecting the quality. Transportation costs are slight compared with those of coal, it being possible to pump supplies from the oil reservoir to wherever it is required at a very slight cost. Labor costs are lower, and the cost of the upkeep of the furnace is practically nil with the use of oil. The app. necessary can be easily adapted to the existing coal furnaces. O. P. R. O.

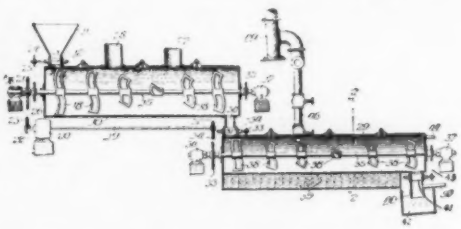
99. Synthetic precious stones. R. QUENSEL. *Geol. För. Förh.*, **44,** 667–9(1922).—*Synthetic rubies* and *synthetic sapphires* have been successfully made from powd. Al_2O_3 in the O-H flame. Coloring agents are discussed. W. S. (*C. A.*)

100. Ore-roasting furnace. ROBERT D. PIKE. U. S. 1,444,209. An app. for the described purpose, the same comprising an outer stationary shell, a vertical rotary

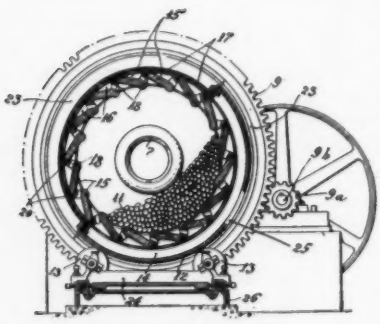


shaft centrally disposed within said shell, a plurality of spaced horizontally disposed hearths arranged within the shell, each hearth provided with outlets for the escape of material therefrom, a series of hollow rabble arms secured and carried by the rotary shaft, means for causing a circulation of a cooling medium through said rabble arms, and a covering of refractory and insulating material for each of said rabble arms.

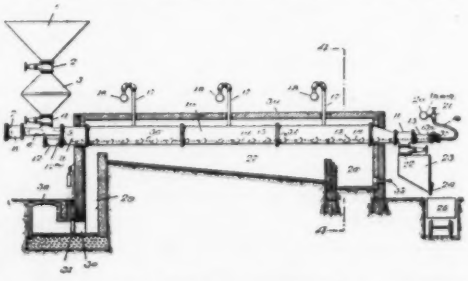
101. Process of treating shale. STEPHAN MARKO. U. S. 1,451,367, Apr. 10. A process of producing combustible gas from oil-bearing shale, consisting in agitating ground shale in the presence of dry heated gaseous products of combustion at temperatures in excess of 600 degrees F, passing the heated shale and gases to a secondary zone of treatment and there continuously agitating the shale and subjecting it to increased temperatures and adding sufficient quantities of superheated steam to the secondary stage of treatment to increase to a predetermined amount the hydrogen content of the evolved gases, separately withdrawing the gas and shale residue from the secondary stage of treatment.



102. Pulverizing mill. RALPH E. H. POMEROY. U. S. 1,451,472, Apr. 10. In a pulverizing apparatus, the combination of a rotatable shell having perforations in its periphery and having therein loose tumbling devices for assisting in grinding the material, means for supplying a current of air inward through said perforations, and adjustable means for shifting said air supply relative to the shell so as to be admitted to different portions of the shell.



103. Oil-shale retort. GEORGE EDWARD HOLMES. U. S. 1,451,575, Apr. 10. Apparatus for distilling oil shale, comprising a heating furnace, a closed horizontal retort, extending through such furnace and subjected to graduated external heat; means for admitting shale into the cooler end of said retort; reciprocating means for stirring the shale when said means moves in one direction and to move the shale along the bottom of the retort in the other direction; means for drawing off distilled products progressively along said retort; means to inject low pressure steam through the agitating means along the bottom of the retort while the shale is in process of distillation; and means for discharging the spent shale at the hottest end of the retort, substantially as described.



THE DIFFERENCE

WHEN the JOURNAL was first started, it carried 7.75 pages of advertising. Since then, it has been growing by leaps and bounds until the August 1923 issue carried 26.00 pages of advertising.

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Of Sanitary and Electrical Porcelain

Recent investigations have shown that the blistering of vitreous white wares has invariably been due directly or indirectly to OVERFIRE or SOLUBLE SALTS.

OVERFIRE It is a difficult problem to produce a practical vitreous white ware body with a long vitrification range, or to always control the kiln temperatures, and blistering occurs if temperatures go beyond the maturing point of the body.

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Another source of soluble salts is the sodium salts used in casting. If ball clays are used, requiring large amounts of electrolytes to produce a good casting slip, they will come to the surface in sufficient quantity during the drying process to cause blistering.

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BULLETIN
of the
American Ceramic Society

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical and Scientific Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

"HE PROFITS MOST WHO SERVES BEST"

Service and Profit.—These have a "cause and effect" relation. There is no just or lasting profit, except through service. Dishonest and incompetent service profits no one. Profit is gotten only through constructive service. A Society is an association for mutual or joint usefulness and profit.

The intent and expectation of the AMERICAN CERAMIC SOCIETY is that it shall render efficiently and timely the best possible constructive service. The SOCIETY has no heart, no mind, no will and no power to do other than is possessed by the members. The SOCIETY is but the means of collaboration of its members in service. The character of service to be rendered by the SOCIETY is the character of service which its members will it to be.

If a member or group of members wish a certain service from the SOCIETY, it will be necessary to do more than to wish; a service of the sort desired can be rendered only when the members themselves render such service. Those who have profited most from the SOCIETY are those who have rendered through the SOCIETY the sort of service they wish the SOCIETY shall render them.

"He profits most who serves best."

PAPERS AND DISCUSSIONS

DISCUSSION ON "ARTISTIC MODERN FAIENCE"[1]

C. DRESSLER:—Several years ago I heard Mr. Bleininger speak anxiously about the condition of the art of pottery, saying that it was more than ever necessary now that the latter should take an artistic direction. As he is a purely scientific man, I was very much struck with this remark. It was entirely my point of view and it greatly strengthened my opinion, as my paper indicated. I should like to encourage the discussion, because I am very much interested in the study and I have no doubt there are views which are diametrically opposed to mine. I should like to hear them, so that I might have the opportunity of defending my views.

I believe that my scheme, if tried out in a large factory might be somewhat costly because it could not be done at once. People have become so accustomed to the present methods of production that it might take quite a time to change, for the foundation of the proposal is to give freedom to the worker. That is, in fact, the whole principle.

The worker at the present moment is under a certain discipline, which is excellent for production, but which is very bad for art. He is told he must do one particular thing only. There is a great deal of division of labor, and so it is quite a small part he is concerned with. He is told also that a large order must be gotten out rapidly.

The plan I propose consists in giving the worker an opportunity to once more use his brains and his taste and feelings. As soon as you begin to do that you may disturb the whole industrial establishment, unless you regulate it and determine limits within which the worker is allowed to use judgment. That is a very important point. Somebody has to say to the worker, "You can use your brains and taste up to this point, but you must not go beyond."

Tradition has been destroyed. We have no tradition. Tradition has to be reintroduced.

Many young artists in France and other places have attempted to compete with large establishments and have failed because they have not been able to turn out the work in time, or they have been impractical. So there is no use in attempting once again in the same way what they have failed to do. That is why I have assumed that a big establishment or factory should take up the idea.

Such a factory is going to look at it from a financial point of view. And that is quite right, because no commercial venture can go on if it costs more than it produces. But I have a very strong feeling that if you give a workman an opportunity of using his faculties, it is going to be a

[1] *Jour. Amer. Ceram. Soc.*, **6** [2], 398 (1923).

wonderful incentive to him, and that, instead of reducing the production, you are going to increase it. I also foresee that it is not going to be at all costly after it once gets going. But to get it going necessarily means expense.

Suppose we have a terra cotta factory for I am thinking of the buildings we see everywhere, faced with glazed or semi-glazed terra cotta. If such a factory tried out this scheme the first thing they would need would be a room set apart with a good light. I do not suppose that would be very expensive. They could find a room with a north light so that the sun would not come in and disturb the effects. Then they would take one or two of their employees who seemed brightest and most interested and make a start. Then I think a very essential thing would be to have a place where the results could be seen and discussed. Therefore, I suggested a little outside wall or courtyard where the pieces could be viewed. I have always liked to put things up at about the height they belonged and to look at them. Sometimes I come to the conclusion that the next thing I do will be slightly different because the effect is not very good; on the other hand, sometimes I am very much pleased with it. So that the opportunity of seeing the work is a very necessary part of this scheme. The factory hand at present never knows what his work looks like. He is not supposed to be interested; but here he would be expected to take an interest. This is an expense.

In regard to materials, I should certainly not introduce any fresh materials to begin with. I should take the clay the factory used. Probably it would be a suitable clay for the work. And whatever it would be, it would have artistic qualities. The point would be to bring out these qualities. Therefore, there would be no extra expense in the matter of the clay. In regard to the firing, this would undoubtedly be the correct one for the clay used so there would be no expense there.

With respect to colors and enamels, I would try to utilize those the factory had. That would be a very essential thing so as not to disturb the business more than necessary. As a rule the number of colors and glazes used is considerable and it is really not a case of increasing the number but, rather, of selecting only a few out of them. So there would be no great expense there.

But there would be other expenses. Somebody has to manage the department, give his whole time and thought to it, and that person has to be paid. And no doubt the results would not be forthcoming immediately. There might be some results at the end of a month or two, but they might not be good enough to be considered worthy of use and it might take several months before you got to a point where you could say, "We are going to put up a façade, or a structure to send to the Architectural League in New York, or some other place, as an exhibit of a finished product we are

proud of." It might take quite a time to reach this point and therefore, it is bound to cost a little money. What this amount is, I cannot tell for there are too many unknown quantities. I have tried to work it out, but I have not been able to get anything definite. But if you want artistic work you have to use the people in a different way from that in which they are being used now, in order to bring out their talent. That latent quality and taste exists among certain people. I do not say everybody has it, but a certain number of people have. That taste is capable of development and it can be brought to a high pitch. You only have to go to Europe, to the places where they do traditional pottery to see some very charming things sometimes at a very small cost. They charm you because there is the human touch there and a sense of proportion. At a place called Mold, in Wales where I went on a walking tour some years ago I came to a little pottery where they made pots and plates and jugs for common use. They had the most charming money boxes with pigeons and other birds on them. These were put there by children and they were most happily arranged. That is due to a natural talent. I am sure that talent exists everywhere, but it has to be brought out again. It has been crushed and it has to be reborn. It has not been absent more than three or four generations; it has to be revived and the conditions under which it can be developed anew have to be considered. This has to be done in the modern factory, because that is the only place at the present moment where such a thing can be done.

MISS M. G. SHEERER:—Mr. Mercer with the Norristown Tile, and Mr. Allen, with the Allenthorp Tile, it seems to me are doing a very similar thing. These are not factories, but they are bringing out the most artistic results and are in no sense commercial. They have made a financial success of it, and if it could be done in that way, I do not see why it could not be introduced into the larger factories.

C. DRESSLER:—That seems to prove my theory, doesn't it?

MISS M. G. SHEERER:—Yes.

MRS. G. O. TOTTEN, JR.:—I think just the same thing has been done in Sweden. I was in charge of this work, producing very good results. The girls I employed were very much interested.

C. DRESSLER:—That is very satisfactory. Did it create a good feeling?

MRS. G. O. TOTTEN, JR.:—A very good feeling, indeed. Afterwards I had to go around and exhibit these things in different cities in Sweden and Denmark and Norway, and that increased the interest still more.

C. DRESSLER:—These were not buildings?

MRS. G. O. TOTTEN, JR.:—No, these were figurines.

C. DRESSLER:—What is true for figurines and small things would be equally true for large work. I am speaking of the modern buildings.

MRS. G. O. TOTTEN, JR.:—I think it could be done.

F. H. RHEAD:—There is one thing to consider; it is one thing to make things in a small way and entirely another to make terra cotta for a forty-story building, involving thousands of tons.

W. D. GATES:—In pottery and with the things cited here, you must remember they kill the imperfect. One good piece comes out, is admired and is handed down, commended; but the bad pieces and the mistakes are broken up. I do not know to what extent Mr. Dressler has investigated the plants that are running today or the methods that are being used but I could not help but think that if he was speaking of trying out the cost of this experiment, he would have to buy a large lot in some one of our cities, and put up a building.

I, too, have dreamed many dreams, and some of them have had sad endings. As a matter of fact, the manufacturer of terra cotta today is absolutely under the control of the architect. We find the architect has a scheme for the entirety of his building, and if you distribute that work among girls and boys to let the individuality of each show itself in the work you would have a hodgepodge in the general result in the building.

I believe in individuality and in the pride of a workman. We have our factory out by itself away from everyone else, much to the horror of many people who cannot consider why we do it. But everyone that goes through that factory says that there is a different atmosphere there from what is found in other places. Someone said to an architect going through recently, "Did you enjoy your trip?" He said, "I should say I did. Everybody met me with a smile, and when I go through some of the other factories I am looking over my shoulder to see if someone is not hitting me with a brick." We do not unduly curb or guide individuality.

The modern building reminds me of a composite picture of a large number of people made by imposing each negative for an instant over a sensitized plate. The construction of one of these large buildings seems to be the composite of all the people engaged in its building, from the mortar mixer clear through. It is a little bit of each man's life, a composite. But it all has to agree with the architects' drawings.

We are kept down, controlled, by the architects and by the owners. Mr. Dressler would have a very hard job justifying the individuality or the carelessness or the conception of the individual workers to the committee in charge of the building or church. Such a justification is absolutely necessary to make collections.

The artistic tendency of the terra cotta man or the potter has but a fleeting reputation. You do not know the potter who made della Robbia ware. Della Robbia was working in bronze and marble, and evidently went to a potter to get clay because he had to model in clay first. They were making enamel which he utilized and today his works are priceless in the best museums in the world. We do not know anything about the

potter. As a matter of fact, there is a glamor that goes with that. Some people consider it a lost art. The potter or the sculptor has a better field to work in today than he had in the time of della Robbia. The della Robbia ware would not stand in this climate. It did not stand exceptionally well four hundred and fifty years ago in the climate of Italy.

I have had this same scheme in our factory, in the modeling room. I have had men who would look at an architect's drawing, and say, "I can give them a better thing than that." That man cannot be employed for though he may make something better in that one individual pattern in the broad scheme of the architect's feeling of what that building will be it will not fit in; the architects have their peculiarities worked into the scheme of the building as a whole.

There is the question of color. For a long time we have had colors and we have tried very many things to bring them to the architects. Many years ago I had Maratta for over a year at the factory, making landscape panels in terra cotta. He painted pleasing ones in water colors. I sent some of these in terra cotta to the Architectural Exhibit in Philadelphia. I was very ambitious, and I thought that by showing a realistic landscape painting in colored enamel the architect would immediately say, "If they can paint a realistic picture in ceramic colors, they can certainly give me anything I need for use in a conventional design." Those panels came back from Philadelphia, thrown into their boxes. I wrote to some friends in New York and got back courteous letters saying their committee for the New York Exhibit had gone to Philadelphia and had looked at these and did not approve of imitation of oil paintings in terra cotta, and then they added, to save me, "You have done so much beautiful work, why can't you send some real work here?" Of course, I became indignant and did not send anything. But that is the way things are looked at.

We have tried to get architects to use colors. They are afraid of them. You can readily see why this is. As you go through the country you see Greek buildings, one after the other. It is a very safe proposition, to take something that has been commended for many generations. You cannot make a mistake. I have had one architect after another worked up to the point of using color, but each time they cut it all out for fear they would make a "botch." It is a dangerous move.

We have tried *individual* work in this way. I think it has to be controlled. Somebody who is running the establishment has to watch the men, to control them and work out something that will be consistent all the way through. If it shows the individuality of any one of the men there is going to be quarreling.

We have gotten the enthusiasm of our men in their work and we have been doing it in this way. The men cannot go to see these buildings because they are very widely scattered, but we get progress photographs

as they go up. We post these on the bulletin board. Each man can say to himself, "There is my work, I did that." But we cultivate the idea among them, not that "I did that," or that "You did that," but that "that building is the collective work of the whole crowd," and their enthusiasm is very earnest. When we get a letter of commendation, as we sometimes do, we post the letter on the bulletin board, and the men feel that they are really accomplishing something that is standing and will stand after they are gone.

The proprietors of the Radisson Hotel in Minneapolis had a cellar they wanted made into a dining room. It was a most desolate looking place and had to be handled very carefully. The ceiling was a suspended ceiling of plaster. There were to be twelve panels around the room, something like twenty-five or thirty feet long and four and a half feet high, and those panels were to have scenes in color from the Upper Mississippi and the Northwest. This thing had to go through the factory in very quick time. That is the thing we are up against all the time. There is no time for experiment. I got Charles Francis Browne, one of the best landscape painters in Chicago, to make small oil paintings of these different scenes. We took these to the factory and reproduced them on five-inch tile set upon an easel the size of the panel, with allowance for shrinkage. They were plastic. We drew the lines of the landscapes in the plastic clay. Then we dried and re-assembled them. Browne selected the colors and tints. You had to know what color you were putting on for when applied they did not exhibit the fired color and tones. We were successful in getting the job through on time and were very much commended.

There are fields of that kind, in which the artist can find opportunity for self expression but there is the imminent haste demanded by commercialism in your payrolls. They are running all the time, and you cannot run very long unless you can make collections.

I think there is a big field for individuality, but this individuality must be restrained, just as our modelers are restrained. We have no particularly lasting reputation. I have been at work forty years putting up these buildings. I go by them and think of the work I went through getting the material there and my part in the erection of the building. The owner or the architect, however, is the one who has the glory, just as della Robbia had the glory. But there is a big reward in feeling that you are making something that is fine. You have to have the enthusiasm of the workman in it or else you do not get a good thing. It has to be controlled, and commercially it has to be controlled by the owner or the architect.

They have a better palette of color now in ceramic ware than ever before. We have had to test each one in our climate. And this AMERICAN CERAMIC SOCIETY has played its part in this wonderful work. When I

look at the five-foot library they have built up, I am filled with pride. My pride is none the less because I really had but little to do with it, but I have had the privilege of associating with the men who were doing it.

MAJOR TOTTEN:—I am not a potter, but I feel that the architects are being criticised in some way in which I do not think that they themselves would like. That is to say, I do not think an architect puts himself up as the primary designer of a building. He says, "I am the designer of the main part of this building, but I cannot succeed alone. I cannot make an artistic production, unless I have the coöperation of artists in all the lines that are connected with this building."

The Public Library in Boston is to my mind one of the best architectural buildings in America, and yet it is quite as famous for its paintings as it is for its architecture. And there is no reason why ceramic work, which is coming up with such splendid strides in America, should not produce works which should be signed by the artist and which should stand just as high as any of the work which the architects do.

There is, also, the question about the construction and decoration in architecture. I have had a feeling for colored architecture for many years. I have tried a few simple specimens, and the question of how terra cotta work should be used in architecture is very puzzling. Architects, I think, do not feel they have entirely solved the problem. There is one class of building, like the Woolworth Building, terra cotta building, in which all the architectural parts are in terra cotta. They might just as well be in stone, and the architectural moldings are designed as if in stone, and yet here and there there are patches of polychrome. The other class of building is that done by the Moors and Arabs; they are not structural at all. They are surface decorations, using a real interior surface decoration put on the outside. That was more or less a questionable external architectural effect. Another method is one by which they use terra cotta and ceramic products in connection with other materials. That seems the most logical thing. For instance, the façade which the American Encaustic Tiling Company has done in New York for their own building, I think, is a very rational thing. They have taken an old house and remodeled it. The effect is a combination of materials by using a plain surface for their masses and then enriched their doorways and windows with terra cotta. That seems to me one of the most rational uses of terra cotta.

C. DRESSLER:—I feel encouraged by what has been said by the several speakers.

Mr. Gates has said that the manufacturer of terra cotta is absolutely under the architect. Now this is a point which I deplore and want to see corrected. Mr. Totten, as an architect, looks upon such a statement as a severe criticism of his profession. The architect should not be the only designer of a building; he can only succeed in an artistic work by the co-

operation of artists in all the branches. It is this artistic contribution that it is the evident duty and privilege of the potter to give. Others beside Mr. Totten hold this view. A member of the Architectural League appealed to the potters for a free artistic rendering of their art in the terra cotta they produce, to get away from the stereotyped imitation of stone or granite. I think that most people are now agreed upon this point.

Mr. Gates has said that if the terra cotta work is distributed among boys and girls and the individuality of each is allowed to show itself, one will have a "hodgepodge". I have been careful to say that I would not allow such a freedom to the workers. I have explained that their faculties, now lying dormant, must be awakened and trained to work in harmony and in unison. It is like an orchestra, of which each member has his limited task under the leadership of an able conductor.

Even with a trained band of workers, under capable leadership, it is quite probable that the interpretation of the design of a modern architect might fail to satisfy him. That is why I propose that the results of the coöperation and coördination of the workers, under this leadership, shall first be expended upon independent examples, which would not be ordered but which would be submitted to architects as specimens of their skill. If, shown in a public place, they succeed in pleasing the architects, these will design buildings in conformity with what they know the factory is capable of turning out.

They may have suggestions of modification and improvement; they may even take a friendly hand in the development of the art. That is exactly what we want. But now, there is no original modern pottery work for them to go upon, so they are restricted to sending potters the ordinary stone building blue prints to which the manufacturer has to conform at his peril.

I appreciate that Mr. Gates' factory is conducted in a very liberal spirit, and that the workers are treated with real humanity; also, that they take a corporate pride in the structures in which they have a hand; but, if Mr. Gates will follow me, he will see that it is a quite different interest and stimulus that I am giving to the individual worker. I am glad to have the experience of Mrs. Totten in support of my theory as well as the further confirmation of Miss Sheerer.

Undoubtedly, the delight in the use of creative taste in coöperation is a powerful element making for good in human work. I use the word "creative" advisedly. Every time that the faculties of man are used freely, they are in a measure creative and original, and their employment is a delight.

Why leave it out, when it is there for your service? Mr. Gates says that the man who sees his way to improve upon the architect's design is a dangerous person. But, properly disciplined, he is the most valuable

person in the factory. His talents, of course, cannot be exerted upon work which has already reached the final stage and been blue printed. Use him in the experimental work and what he does will appeal to the very architects who would have every reason to resent his making modifications in their finished plans.

Another thing, which I think Mr. Gates did not apparently quite realize, was why the architects failed to appreciate the reproduction or copying in faience ware of paintings in oil or water color. The fact is that they would not know of the enormous technical difficulties overcome, and of the handicap of our altogether too short space of time to do the work in. They would judge only by results.

Copies never are satisfactory. That has been proved over and over again. It seems like a law of nature and I believe it to be a beneficial law. It makes necessary the use of the creative faculties whenever anything really beautiful is aimed to be done. A good oil painting we know gives great pleasure; done with pottery or tapestry, it loses its charm.

I do not know whether Luca della Robbia fired his own pieces. I fancy he did, with the assistance of his nephew, Giovanni. I am glad he was mentioned, for I should like to see the potter receive the credit for his work, and a beautiful building be ascribed to him, no less than to the architect who supplied him with his opportunity.

What I am advocating is now desired by many thoughtful people. It is bound to come about, sooner or later. Let me repeat that it is not really a very expensive experiment, because it will have the hearty coöperation of the workers, and because as soon as good results begin to appear they will gain favor with the architects and the general public. The potter, who has the vision and the courage to make a start along these lines, will lead in this great and important field, and gain his reward. I hope that Mr. Gates will be that potter.

DISCUSSION ON "THE MECHANICAL STRENGTH OF GLAZING GLASS"[1]

CHAIRMAN HOSTETTER:—This interesting problem on the tensile strength of glass is open for discussion.

J. H. FORSYTHE:—I think the work should be carried on as he pointed out.

A. E. WILLIAMS:—The results shown we thought were pretty consistent for the rough rolled and wire glass, in which we tested five days glass at

[1] A. E. Williams, *Jour. Amer. Ceram. Soc.*, **6** [10], 981 (1923). Received too late to page with original paper.

the same factory. We showed a variation for one day, a modulus within ten per cent. That is not the maximum: that is the average variation from the average volume.

Now, for the thinner glass the variations ran greater than that and in some cases as high as twenty per cent. I have a few figures here. The maximum average for any one day of about twenty days' production at the factories, the modulus was 8600 maximum and 5500 minimum. That minimum is for rough rolled glass. For ribbed glass the maximum was 5700 and the minimum was 4600. For plain rough wire glass the maximum was 7900 and the minimum 5600. That represented different factories.

For ribbed rolled wire glass the maximum was 7300 and minimum 6200.

For corrugated wire glass the maximum was 17000 and the minimum 12900.

For $^3/_4$-inch deep corrugation, the maximum was 10,000 and the minimum 9100.

For polished plate the maximum was 6900 and the minimum 6000.

For unshatterable glass the maximum was 9500 and the minimum 6700. There was quite a variation.

On the clear sheet glass we got the greatest variation. The maximum was 12,700 and the minimum 6000.

I have also taken an average for these various types of glass which you might recommend for up to date engineering practice in figuring strength for construction purposes:

Single and double strength, or 26 ounce	7000
Heavier sheet glass and quarter-inch plate	6500
Rolled sheet and wire glass	6500
Ribbed rolled sheet or ribbed wire glass	5300
Corrugated glass	13,500 and 9500

SULPHURING OF GLASSES[1]

By J. C. Hostetter

J. C. Hostetter:—I suggested this title to find out something from the discussion. Apparently sulphuring may be the result of several causes, one predominating at one time, and another at another time under some other conditions. Sometimes it takes place in the working of the glass, sometimes in the leers. I should like to see the situation reviewed and perhaps some conclusions reached.

Mr. Ford explained that they have not attempted to study this feature, but have simply studied the effect of moisture on the glass. That when

[1] Glass Division, Pittsburgh Meeting, Feb., 1923.

a rubber stopper was used the surface was more clear than when using a cork stopper.

Mr. G. V. McCauley stated that some time ago his plant had had trouble with bulbs which came back with a white formation on the inside and outside. He further stated that a half dozen men at his plant got together for the purpose of ascertaining where this came from, and that after a little investigation they traced it, as they thought, to the glue used for putting the two outside papers on the corrugated padding; that it comes out and affects the glass when this glue is moistened by water, steam, or the like.

Mr. A. Silverman stated that the silicic acids were very weak and that possibly the organic acids might be stronger than the silicic acids, which would account for the reaction.

R. R. Shively remarked that he had had experience with sulphuring of jars in leers, but that this deposit seemed to form as the jars cooled, as those taken out of the hot part of the leers did not show the deposit.

CHAIRMAN HOSTETTER:—Your statement is that an extreme oxidizing condition is desirable in your particular case.

The paper that appeared in the *Journal of the Society of Glass Technology* a year or two ago indicated that a reducing atmosphere for light glass was desirable, thus going back to the idea of having charcoal in the glory hole, all the time. The rings you describe on the jars: did they appear immediately as they were taken from the leer or glory hole?

R. R. SHIVELY:—From the leer, and they were not heavy.

CHAIRMAN HOSTETTER:—I have seen this phenomenon. As the ware was taken from the glory hole it would show signs of surface discoloration. They could be washed however. The lines would show up under the action of water.

R. R. SHIVELY:—I have noticed a ring formed on the ware warmed in a glory hole fired with gas containing sulphur. This was eliminated by running an oxidizing flame. After washing this ware, these rings were more pronounced.

DISCUSSION ON "A STUDY OF THE ORIGIN AND CAUSE OF STONES IN GLASS"[1]

A MEMBER:—Is it possible to add material which may cause the glass to boil in the melting end of the tank and may tend to keep the scum down or remove it after it is once formed?

H. E. INSLEY:—Any action which would bring materials of higher specific gravity to the surface would probably remove the scum. The addition of salt cake to the melt might also remove the scum.

[1] H. E. Insley, *Jour. Amer. Ceram. Soc.*, **6** [6], 706 (1923).

R. J. MONTGOMERY:—We often had white surface scum, but we have cleared this up. We broke up that surface. We have been able to improve the quality immensely by stirring.

A. E. WILLIAMS:—What are the different ways in which corundum may be formed in the glass furnace?

H. E. INSLEY:—In the case of the formation of corundum on clay blocks above the glass surface, there must be excess of alumina. After the absorption of soda from the furnace atmosphere and the formation of the sodium aluminum silicate which is liquid at furnace temperatures, the excess of alumina will crystallize as corundum. In the case of the formation of corundum in flint glass not exposed to the soda in the furnace atmosphere, there is often direct conversion of the dehydrated gibbsite or diaspore to corundum.

H. W. HESS:—Some years ago, not being very familiar with this type of work and hunting for the causes of stone in heavy glass, I had to seek aid from the outside. We took an ordinary pot holding about three thousand pounds of glass and introduced fragments of pot clay of various sizes and closed up the pot, and after two days I took out samples and examined them and then compared them with stones that they had found in glass in process of manufacture. We closed the pot up again for several days and kept that procedure up, just holding this one pot for that type of work until the stones gradually disappeared, and we found a long line of threads where the crystals were carried away by movements of the glass although the inner structure had entirely disappeared. Experimenting along that line, as regards stirring, while stirring the entire crystal structure disappeared. Some of these experiments were carried over four weeks, and I have wondered whether such work was being done. That gave me a great deal of information that I had not been able to gain otherwise.

H. E. INSLEY:—That is the kind of work we want to do at the Bureau later. So far we just have examined stones sent into us. We would be glad to examine any forms of crystalline material sent in to us. We are very anxious to have samples of any kind of stones.

M. G. BABCOCK:[1]—The writer has seen several samples of stony glass which appeared on first analysis to be clay pot stones. In the particular factory where this occurred, they were melting a fairly heavy lead potash glass batch in covered pots. A part of the K_2O in the batch was obtained by substituting some niter in place of all potash. Instances were noted on several occasions when the pot planed up and the stopper removed, that the gathered metal was full of small stones, making the pot unfit to work. However, by stoppering the pot for another twenty-four hours, the stones disappeared. On first inspection, this type of stone had all the earmarks of a clay pot stone, but the very fact that on the second day it had dis-

[1] Written discussion received April 20, 1923.

appeared, proved to the writer beyond all question that these stones were not from the pot but were batch stones.

In many factories clay pot stones are made more numerous and objectionable by the rather common practice of scraping pots. It has been the writer's experience to note that pots which were scraped on Saturday afternoon and were opened up on the following Monday for working the glass, invariably would be stony. The reason for this condition being that the bottom of the pot is cooler and the glass in this region is more viscous, thereby keeping small clay points from the gathering pipe. But should one stir up this metal by scraping, the viscous glass would pull off many protruding particles of the eroded pot and hence many minute refractory pieces would become a part of the next melt, thereby forming numerous stones, these stones becoming evident as the glass is gathered for presser or blower. This condition exists mainly in pots that have been in use for some time.

The subject of pot stones is one which is most important both to the glass manufacturer and the maker of pots. It is a recognized fact that at this writing the pot maker has been unable to find clays or combinations of clays which will entirely eliminate all of the stony glass problems coming from the pots themselves. On the other hand the user of pots may decrease his stony glass troubles by closely watching the effect of his batch materials, the burning of his pots to a high temperature before glazing, and, by being most conservative in following the practice scraping pots.

DISCUSSION ON "SILICA CEMENT"[1]

F. A. HARVEY:—Mr. McGee's paper brings out in a very clear manner the importance of silica cement. Comparatively few users pay any attention to the quality of silica cement as long as the boss mason is satisfied and he usually wants a smooth working cement and asks for nothing more.

I should like to emphasize Mr. McGee's point that the softening temperature or fusion point is very easily and quickly determined by the A. S. T. M. standard method. Also it gives much more reliable results than chemical analysis. Alkalies have much greater effect in lowering the fusion point than does a change of one or two per cent in the alumina content. A decrease in the lime content by using raw rock instead of bats will raise the fusion point several cones.

Chemical analysis is of no value whatever unless the total fluxes are considered and even then it has no purpose except to control the fusion point. So why not make this test in the first place.

[1] E. N. McGee, *Jour. Amer. Ceram. Soc.*, **6** [8], 896 (1923).

The per cent of clay is quickly determined by finding the per cent weight lost and heating the cement to red heat and comparing it with the per cent weight lost by a sample of the raw clay used in the mixture after heating. This method is much more rapid than the chemical analysis and just as reliable.

It is doubtful whether there is any advantage gained in trying to balance the shrinkage of the clay by the expansion of raw rock. The real advantage gained by using rock is the higher fusion point.

DISCUSSION ON "MOLD SHOP PRACTICE"[1]

W. D. GATES (Acting Chairman):—The departure from the old method of secrecy as shown by Mr. Klinefelter is an excellent point in his paper.

SECRETARY CLARE:—Mr. Klinefelter made the statement, that it is cheaper to throw up a mold than it is to cast it. We find that casting gives a much more solid mold, more fool-proof, and it lasts longer. I do not know but what it is about as cheap.

There is also a question of making a cast mold for plaster pieces. That is quite expensive. We should have to consider there whether it would pay even to make a piece mold although I think it would.

The paper on the Miter Cutter Department is the first instance of a paper of this type. That is rather a neglected department and one where a lot of unnecessary money is spent. In most cases in the Miter Cutter Department they do as Mr. Klinefelter says: "They stick a soft piece on to a hard piece and they get unequal shrinkage resulting in a crack, or too hard finish." My plea has been to reduce cutter material to a minimum, except where it is too costly.

I think it is a very crude practice to work on pieces in a semi-shrunk condition. We do not know just how much shrinkage it has had, sometimes it has been pressed four hours, sometimes 10 hours, and sometimes 2 days. This shows that this department could bear much thought and investigation. I have been able to pick out miter cutter pieces on a building by just looking at the take-up.

T. A. KLINEFELTER:—On piecework one mold maker can usually take care of four to six pressers week in and week out without a bit of difficulty.

ERNEST CLARK:—I have discovered that cast molds stand up. I had a continual run of molds coming back from the pressing shop and I decided that the best was the cast mold.

On a double-ended miter we put what we ordinarily know as sides on first, then the two ends and you would be surprised what difference it

[1] T. A. Klinefelter and F. C. Parsons, *Jour. Amer. Ceram. Soc.*, **6** [7], 783, 786 (1923).

makes. We did have some trouble on account of the depth and a few years ago we used to try to save as much ending as possible.

We made a rabbet all the way from $^1/_2$ to $^3/_4$-inch and that caused the cracking which you mentioned. We reduced that rabbet to $^1/_4$-inch for a cornice piece and have not seen a cracked piece from that time on. It eliminated all the trouble.

A man who is practiced in throwing up a mold can throw it up quicker than he can put up parts, but the plaster mold loses its strength. I believe that the cast mold is the most substantial and the cheaper mold in the long run, especially on big jobs where there are many runs on the same mold.

We have very little trouble with our miters, but invariably if you do not have plenty of room to reinforce the corner it is going to use itself up because in the drying there is not enough clay there to hold the pieces together and it will invariably crack.

I think that in everything Mr. Klinefelter has shown there is good. We have tried to follow that practice right along and our men have gradually got into that way of working and we have very little trouble. The mixing of the plaster has a great deal to do with it.

CHAIRMAN A. F. HOTTINGER:—We have all grown accustomed to these big rabbets. It seems to be very nice providing space for an amount of mortar between the two pieces of sufficient thickness that it will make a strong structure. But as a matter of fact this is all lost in the setting of the terra cotta. The rabbet weakens the face of the piece and no mortar of any consequence is put in, the rabbet not being filled. Any expansion or contraction (contraction particularly) brings a strain. Of course, the depth of the rabbet is of advantage where you have to grind the piece but you will have to grind no more off the piece if the rabbet is more shallow.

DISCUSSION ON "TRANSPARENT ENAMELS"

LED BY THOMAS A. WRY

T. A. WRY:—I should like to obtain a highly-polished steel surface and have on that surface an enamel that will not impair the reflecting-power of the surface and will withstand weathering conditions.

R. R. DANIELSON:—During the war the Government was interested in a large reflector that would not be affected if hit by a bullet. We attempted to enamel silver at that time and attempted to get the same results as you did by forming a polished silver surface. We were not able to get what we were after. The coating of glass on the silver surface cut down the brilliancy. I am inclined to think it is impractical to do it.

R. D. LANDRUM:—I understand in Europe there is such an enamel on

steel. We all have gotten certain glazes that would adhere to the steel and show the steel through.

H. F. STALEY:—It is a difficult proposition. In order to have the enamel stick to the steel you must use a ground coat which tends to dissolve the surface with more or less corrosion whereas in order to get a mirror-like effect you have to have a highly polished surface. In other materials, for instance, in gold, they do that. You can see the material right through the enamel. Perhaps Mr. Wry could solve the problem by trying some other material. All transparent enamels on steel which I have attempted to burn have turned more or less black.

DISCUSSION ON "ZIRCONIA IN ENAMELS"[1]

A MEMBER:—Was that commercial zirconium?

W. F. WENNING:—In the white enamels tests we used pure zirconium and not commercial zirconium.

H. C. ARNOLD:—How did the substitution of zirconium oxide for tin oxide affect the fusibility?

W. F. WENNING:—The fusibility was increased.

H. C. ARNOLD:—Did you get greater acid resistance when the zirconium was added in the mill, in the batch, or both?

W. F. WENNING:—The greater resistance was noted particularly in the batch additions.

H. C. ARNOLD:—That checks our experience. When added on the mill the resistance depended more on the resistance of the gloss.

E. P. POSTE:—What did you mean by higher fusibility?

W. F. WENNING:—Increased refractoriness.

W. J. VOLLRATH:—How did a small quantity affect it?

W. F. WENNING:—It went from one up to 10%, and the fusing point was not affected in batch replacements.

H. F. STALEY:—You said the objection to zirconium oxide was the high price. Is the price prohibitive?

W. F. WENNING:—Yes. The price prevents it being used in commercial enamels.

H. F. STALEY:—How cheap can pure zirconium oxide be produced at the present time?

F. R. Glenner:—I do not think we are quite in a position to state what the exact price would be at the present time, but we are working on the problem and we think we shall in a short time be able to produce material analyzing over 99% in purity at a price very close to that of tin oxide. Our present production leads to this conclusion. This is of great importance to enamelers.

[1] W. F. Wenning, *Bull. Amer. Ceram. Soc.*, **2** [5], 102 (1923).

W. F. WENNING:—Have you any idea what pure zirconia sells for now?

F. R. GLENNER:—We are able to produce it now at a price close to seventy cents per pound but, as previously stated, it will have to be about equal to the price of tin oxide at the present time, if it is to compete with the latter, as it replaces it pound for pound. That seems to be brought out in Mr. Danielson's report. We feel thoroughly confident of bringing down our cost with increased production to enable the enameler to replace tin oxide with zirconia.

B. A. RICE:—How did you test the elasticity of the enamel?

W. F. WENNING:—We enameled pieces of sheet metal twenty gage, 3 inches by 5 inches. They were bent over a specially devised jig. Enamels that would crack while bending through small angles were considered to have low elasticity, while those enamels which could be bent through greater angles were considered to have greater elasticity or stronger.

B. A. RICE:—How were they bent?

W. F. WENNING:—By hand. The adhesion in turn was tested in a similar way. Those enamels which jumped off the iron while being bended were considered to have poor adhesive qualities.

F. J. JAEGER:—Do you not get an entirely different result in the bending according to the quantity of enamel applied?

W. F. WENNING:—We applied a uniform quantity on all tests. We were aware of the fact that various thicknesses would vary the results. We used only one coat in most tests.

J. A. AUPPERLE:—Did you test out the zirconium enamel for acid resistance?

W. F. WENNING:—We compared the acid action on the zirconium enamels to acid action on other enamels relatively.

M. E. MANSON:—I had samples of two different concerns. Each said they had zirconium oxide, but they really had zirconium hydrate. Was your material zirconium oxide or zirconium hydrate?

W. F. WENNING:—We used pure zirconium oxide.

F. R. GLENNER:—It would be quite enlightening in the application of zirconium oxide if Mr. Danielson would follow up his tests with data showing the success of pure ZrO_2. I should judge that the closer you get to 100% purity, the better would be the results in the enamel. It would be interesting to see how that worked out in practice.

R. R. DANIELSON:—The tests were made some time ago when it was difficult to obtain the pure zirconium oxide.

H. C. ARNOLD:—In literature I have seen a number of references made to basic zirconium silicate, especially in foreign literature. I wonder if any one has had any experience in using basic zirconium silicate.

L. J. MUNROE:—I had some experience, but it was not of a pure grade.

Any man almost can use tin oxide with safety. Zirconium seems to take more technical skill. My experience shows that I had to be more careful in burning than was the case in tin oxide. But I am not present to say what can be done with zirconium.

A MEMBER:—There is one point I do not understand. Why does zirconium oxide have to be so pure? Why could we not use the ore and take out the materials that would cause discoloration and have for use about 85% zirconium oxide?

L. J. MUNROE:—At the smelters that could perhaps be done, but in the enamel plant I do not believe that it would be practical.

F. R. GLENNER:—Has Mr. Danielson data on titanium in connection with zirconium oxide? Perhaps even a small percentage of titanium would affect the results.

R. D. LANDRUM:—There is very little data on the subject and I think it would be well if some of the committee would work with it and give us their results.

Every ounce of tin oxide we add makes it less enamel, for the tin does not go into solution. The few results that we have obtained with zirconia shows that though it may be an opacifier it also increases corrosion resistance. It is a point to be considered and upon which somebody should spend considerable research.

DISCUSSION ON "RELATIVE MAGNITUDE OF RADIATION AND CONVECTION IN A MUFFLE KILN"[1]

W. ROSENHAIN:—I am inclined to suggest, tentatively, that it would be desirable to be a little cautious in accepting the author's generalization because convection is not a constant thing; it depends upon the particular circulation of gas you have in your furnace. The amount of heat which the surface can absorb by convection is a function of several, one of which is the velocity at which the gas is moving, consequently it all depends where you place a cylinder like that as to how much heat it will absorb and what radiation you get. These figures are very interesting, yet I am not at all certain we will be safe in applying it equally.

In regard to the temperature of the water inside the cylinder, he tells by the amount of heat communicated to this how many calories per second are passing through the copper. I never worked this out, but there must be a difference of several degrees between the outside and inside. Certainly there is room for correction there.

J. T. LITTLETON:—Dr. Rosenhain's point in regard to the variation of convection in different forms of kilns and so forth is very true. I attempted

[1] J. T. Littleton, *Jour. Amer. Ceram. Soc.*, **2** [7], 771 (1923).

to bring that out in my statement. These data would only apply to this one particular kiln. The point of position of the surface subjected to convection heating, of course, is extremely important. In this case it was somewhere near the center of volume of the kiln, at a place where it was subject to a good average condition. The temperature gradient through the copper vessel was much less than 1 °C. However, as was pointed out the error would be negligible so far as radiation is concerned had it been ten degrees.

DISCUSSION ON "THE FLINT CLAY SITUATION IN PENNSYLVANIA"[1]

A MEMBER:—Is it agreed that the quarry rock is better than the ledge rock for ganister?

R. W. STONE:—Last summer I tried to cover as much of the state as possible. In 2400 miles, I saw no place where rock was being quarried for use as ganister. It was in every case the talus. That may simply be an economic proposition. It is easier to pick it up than to quarry it by the use of expensive explosives. The outcrop has been subjected to weathering sufficiently so that the soluble material has been extracted. There is little left but the silica and it is freer from iron.

CHAIRMAN J. S. MCDOWELL:—In our own experience in the quarrying of quartzite in Pennsylvania, I think it is true that the talus rock is almost invariably purer than from the solid measure, although there is a great deal of solid measure rock of high purity.

A. F. GREAVES-WALKER:—If that is the case, will not the talus rock be exhausted and the silica reduced to disappearing point within the next few years?

J. S. MCDOWELL:—I do not think so. There is sufficient talus to keep the brick works going for a long period of time and there are a good many of the solid measure deposits which are extremely pure. They probably will not be worked to any extent as long as the talus is as abundant and readily available as it is now.

R. W. STONE:—It seems that the talus in the immediate vicinity of Mt. Union, Pa., is rapidly being exhausted, but the formation, the Medina, outcrops all the way from the southern to the northern boundary of Pennsylvania, loops back and forth and repeats itself, and for a hundred miles the talus lies below the outcrop. I was particularly impressed by the great rock slides along the mountain-ridge with talus the whole length. Very little of this is at present time accessible to railroads. It means the building of tram roads to get to it. There is an enormous quantity

[1] G. H. Ashley, *Jour. Amer. Ceram. Soc.*, **6** [7], 837–49 (1923).

of talus of the highest grade to be obtained that will last the refractory industry of this state for many years.

F. A. HARVEY:—My own company and at least two others are using a large proportion of solid measure rock and have been for several years. We produce a very successful brick. As to the purity of the material, the best analysis which we have ever had, came entirely from solid measure rock. An analysis showed iron about $^{7}/_{10}$ of one per cent, and alumina considerably under one per cent. The greatest difficulty we find is that the solid measure rock is so hard that it wears the pan castings too fast in grinding. It is our ordinary practice to mix the talus with it to be able to grind the rock easier.

A MEMBER:—How much lime?

F. A. HARVEY:—There is about $^{2}/_{10}$ of one per cent.

H. INSLEY:—Do any of the flint clays of Pennsylvania contain diaspore nodules?

F. A. HARVEY:—Some of them do.

J. S. MCDOWELL:—How long are the flint clay deposits going to last?

R. W. STONE:—It is the impression that the deposits are comparatively scarce and it will not be many years until they will be much more valuable than they are now.

J. S. MCDOWELL:—Can you give us any data?

R. W. STONE:—The personal opinion of Dr. Ashley is that there are considerable sections of the bituminous coal measures and he is firmly convinced that there is a sufficient quantity of the flint clay and of the soft clay to supply the industries of this State for a good many years, which is a little bit more than the "many" he used for the talus. He has no fear that the producers in this state will be obliged to go outside of its boundaries for its refractory materials for a considerable time to come.

DISCUSSION ON "NOTES ON BURNING REFRACTORIES WITH SPECIAL REFERENCE TO CONTROL OF LABOR COSTS"

E. H. VAN SCHOICK:—How long has this system been in operation?

L. C. HEWITT:—Four or five years.

MR. ALLEN:—Mr. Hewitt, in your work did you find that a bonus system was sufficient incentive to get the men to be interested in it?

L. C. HEWITT:—Yes, but we had some trouble getting the thing over. We had actually to show the firemen that they could easily do the work with fewer men—the added earnings did the rest.

MR. ALLEN:—We put the bonus system in our plant. We made a time study and found they were running, on an average, 50% efficient of what

[1] L. C. Hewitt, *Bull. Amer. Ceram. Soc.*, **2** [5], 109 (1923).

they could do and made that a basis of pay and found that by offering an inducement of $37\frac{1}{2}\%$ increase in pay for 60% increase in production they could go right after it. That is, for each 2% increase of production above fifty, the men would make one cent per hour more. Anybody on that basis could make some money. They found they could get a little bonus and do a little more work. We have had them get 80% on that basis. It has been particularly successful in hand molding and finishing. In some of the other operations where you have variable conditions like wheeling in clay when the clay is frozen, we have to change our rates to allow for that and it is rather questionable in that particular case. Of course, we have to allow for breakdowns in machinery. The men are not responsible for that. There is also a tremendous amount of work involved in this kind of thing and while it does speed up production, it remains to be seen whether it actually pays.

L. C. HEWITT:—It pays well in our particular instance.

E. H. VAN SCHOICK:—Have you had any experience with men who did not earn any bonus; men who were earning the bonus right along and for some reason, possibly not their own fault, they did not make it for one week.

L. C. HEWITT:—Yes. We went through a very heavy rain—almost amounting to a flood—necessitating extra labor far above normal. You have to allow for a condition of that kind.

E. H. VAN SCHOICK:—Where the men have been earning the bonus for any length of time, they come to think of that as their wage. If they do not earn the bonus, they have the idea that the company is cutting their wage and it is troublesome.

E. E. AYARS:—Do I understand, Mr. Hewitt, that you make allowance for abnormal conditions or force the men to make allowance?

L. C. HEWITT:—We allow for them—but allowances that are necessary are surprisingly few. The regular fatigue allowance takes care of many little things that come up. When some big abnormal condition arises, conditions are changed and you have to change your basis. We do not change the bonus system as long as the conditions remain as they were at the time the system was established, no matter how much the men make by increasing their efficiency. Increased earnings for the men means increased earnings for the Company. If the men desire to exert themselves above normal to earn bigger money, they need have no fear that the bonus will be cut, as is often the case in piece rates when a company decides that the rates are too high when the men go after higher wages in earnest. With the bonus system, a man can earn good money by doing a fair day's work. If he feels like going beyond that he can. The man who does more work will get more money.

A. HAYES:—Do you make any allowance for the variation in the time

of firing a kiln where they have from kiln to kiln a different type of ware, large slabs, pieces of heavy cross sections, etc.

L. C. HEWITT:—No, as explained in the outline, we have, in this particular example, four definite temperature ranges, 0–500°, 500°–1150°, 1150°–1400°, and 1400° to finish of burn. The standard man hours per shift for firing a kiln while it is in a particular stage is constant. Assuming that the standard is two-man hours per 12-hour shift for the range 0–500° and it takes 24 hours to take the kiln through this period, the standard would be 4 man hours. Likewise if on account of heavy pieces as you mention it was found necessary to take 48 hours in bringing the kiln up to 500° the standard would be eight man hours (4 times the constant standard for this range of two man hours per 12 hour-shift).

DISCUSSION ON "THE SLAG TEST" AND "THE ACTION OF SLAG UPON SILICA, MAGNESITE, CHROME, DIASPORE AND FIRE CLAY REFRACTORIES"[1]

R. F. FERGUSON:—The present slag test is a measurement primarily of penetration and the result of chemical action is largely obscure and very little information is obtainable except a measurement of the absorption of the brick. We hope to be able to develop a slag test which would measure the chemical action and eventually give practical information which would make it possible to predict beforehand the chemical action of a given slag on any refractories and we think we have at least partly accomplished this. The theory on which the test is based is simply this. When refractories are heated, compounds are formed with a low fusion point, and the extent to which this is lowered is taken to indicate the action of the slag on the brick. That is what happens in practice. The brick and slag in contact form a low melting compound, fuse and scour away. The method of procedure is simple enough. The refractories were ground until they were all of the same degree of fineness. In this case, it happened to be 80-mesh. The slags were finely ground and were mixed with the refractories. We mixed up batches of various kinds, with no slag, 4% slag, 8% slag, 16, 30, 40, and 50% slag. We investigated five different types of slag. These slags were brought in contact in these proportions which I have mentioned, with eight different kinds of refractories. Five different types of fire-clay brick, having a wide range of composition, were used. All the bricks selected were considered first quality bricks for the particular type of service for which they were used. The results are very encouraging. I have only picked out a few very representative results with which I will give you an idea of what the test will do.

[1] R. M. Howe, S. M. Phelps, and R. F. Ferguson, *Jour. Amer. Ceram. Soc.*, **6** [4], 589 (1923).

These tests, you notice, will agree with service conditions in three important respects. The fusion point depends upon the amount of slag present. Different slags behave differently with different refractories. With a given refractory, the action of the various slags is comparable. Also, with different slags, different refractories give different values. Consequently, with these three things in mind, we believe that the use of the test is justified, and that further study will give a great deal of valuable information on the effect of slag on refractories.

A. KRUSEN:—I should like to know what alumina content you would consider a diaspore brick. As I understood, that brick contained approximately 60% alumina and I wondered if that was a true diaspore or if a true diaspore would contain more than that amount.

L. C. HEWITT:—It might be stated that any brick which shows a predominance of diaspore crystals can rightfully be termed a diaspore brick. In Mr. Howe's discussion at St. Louis a year ago, it was also developed that we might expect a considerable range in the alumina content of various diaspores. The diaspore brick may also be made either from straight diaspore or from a combination of diaspore and bond clays.

E. N. MCGEE:—We made an investigation at Syracuse on the effect of lime at the fusion point and we ran across this thing that Mr. Ferguson has explained. With silica brick, the addition of lime did not decrease the refractoriness very much. Five per cent lime would decrease the refractoriness to about cone 28, while with clay, the ordinary fusion point would be about cone 12 or 13. I wondered at first what the reason for that was because if you take a brick and place it in the furnace, place lime on the brick and heat to 1350°, the lime will fuse right on the brick and all disappear.

ACTIVITIES OF THE SOCIETY

PRESIDENT'S PAGE

A CALL TO ACTIVITY

By President A. F. Greaves-Walker

An intensive effort to increase the membership is under way. Every Society officer, Section and Division officer, every committeeman and every member is asked to put his "shoulder to the wheel" and make this the greatest drive in the history of the Society. It is surprising how many there are who will join the Society if invited. So many of these are under the impression that they are not eligible.

A Michigan Section has been formed and started off auspiciously by acting as host to those attending the Summer Meeting. This Section is in the hands of some of the strongest and most enthusiastic members of the Society and its success is assured. The best wishes of the entire membership go with it.

Two Pacific Coast sections now seem assured, probably centering around Los Angeles and Seattle. There is a wonderful opportunity for local Sections on the Coast, especially as the members out there are so far removed from the center of activities that they must in a measure furnish their own contacts in order to derive the greatest benefit from the Society. The holding of the next Summer Meeting on the Coast will do much towards speeding up the necessary preliminaries to organization.

With the Summer Meeting over we begin to look forward to our Fall Meeting at the Chemical Show in New York in September. The success of this meeting is assured and it is expected that Ceramic Day, Sept. 19th will show the largest attendance in the history of this annual affair. The Committee on Papers and Programs are preparing an excellent program which will soon be announced.

WHY IS A CERAMIC SOCIETY?

By R. F. Ferguson

"Why is a policeman?" used to be a favorite conundrum in the days before the red tag system was invented. And we have just as much right to ask, "Why is a Ceramic Society?" We all know there *is* one, especially those of us who serve as officers and committeemen. But does it have any excuse for existing? Organizations have been known which were created because "there ought to be one." Does our Society come in this class? Do we get anything for our seven-fifty besides a card and a *Journal?* And those who have been selected or elected to keep the mails filled with blue tinted letters, are they the "goats" or do they derive a benefit from it other than typewriters' cramp and the reward Virtue is supposed to bestow? To answer these questions we must delve into the realms of psychology, a risky thing for a ceramist to do, undoubtedly.

Professor William James divides the self into three parts respectively: the material self, the social self, and the spiritual self. Furthermore, he claims that "a man has as many social selves as there are individuals who recognize him and carry an image of him in their minds." But these individuals naturally fall into groups and to each of these groups we show a different self. The Ceramic Society is such a group and one of its purposes is to develop our professional selves. And this professional self *must* be de-

veloped in most of us if ceramics is to be a life work and not a dreary way of making a living.

To the big boss I am one of the help; a doubtful bargain on the part of the payroll department; a necessary evil that must be added to the bug-a-boo overhead because not directly in line with production. To my neighbors I am a poor ass who wont buy his family a car; a good-hearted sucker who works hard for what he gets, and who doesn't know when his hair needs cutting and his trousers need pressing. If these were the only Mes I had to live with, I would find myself poor company. The African explorer, world traveller, and heavy weight champion who used to tell me they would be waiting for me when I grew up are not to be found. The man my mother thinks I am has gotten too far away to be recognized.

But, now, in comes another Me. It is the image that the fellow members of the AMERICAN CERAMIC SOCIETY, present and future, carry in their minds and it brings much satisfaction, inspiration, and encouragement. It is a wonderful Me, of a delicate blue tint, with a copy of the *Journal* under each arm. An ardent searcher for truth who wishes nothing better than to uncover some obscure fact whereon other workers may build and which abstractors can tuck away in a card index. A Me whose name is already in that pantheon of our student days, the authors of the technical literature; an expert who knows the haunts of molecules and whose opinion is to be sought; an *ipse dixit* to the young student; a professional man who hews unflinchingly to the dead log of error and lets the stockholders dodge the chips. And this is the Me that takes the labor out of laboratory, the burning bush that makes my study holy ground. And this particular social self, this baby-blue Me, would not be possible without the AMERICAN CERAMIC SOCIETY.

NEW MEMBERS RECEIVED FROM JULY 16 TO AUGUST 15

PERSONAL

E. B. Baker, 764 Military Ave., Detroit, Mich. (Star Grinding Wheel Co.)

W. H. Ball, Ball Bros., Muncie, Ind. (Ass't. Gen'l. Manager.)

Ellridge J. Casselman, University Club, Pittsburgh, Pa. (Industrial Fellow, Mellon Institute of Industrial Research.)

Leon B. Coffin, 310 Cayuga St., Syracuse, N. Y. (Onondaga Pottery.)

Thos. R. Davison, 187 Jennings Ave., Salem, Ohio. (The Salem China Co., Supt.)

Eldon B. Flu, % Champion Porcelain Co., Detroit, Michigan. (Chemist.)

Jno. M. Gibson, 120 North Park St., Edgewood, Wheeling, W. Va. (Foreman.)

W. S. Hamilton, Celito Products Co., Lompoc, Cal. (Sup't C—22 Brick Plant.)

F. Heinrich, Eisen & Stahlwerk Hoesch, Forschungsanstalt, Dortmund, Germany. (Director of the research dep't. of the Hoesch Iron & Steel Works.)

Everett Curtis Hunting, 326 Clark St., Olean, N. Y. (Student N. Y. State School of Ceramics.)

Fred P. Johnson, 335 W. Ave. 26, Los Angeles, Cal. (Stone Ware, Foreman.)

Oscar W. Kraft, 3350 Scotten Ave., Detroit, Michigan. (Ass't Superintendent.)

Cyril Kussman, % Favorite Stove & Range Co., Piqua, Ohio. (Foreman.)

Irving B. Laud, 70 W. Boylston St., Worcester, Mass. (Norton Company.)

Otto Oscar Malleis, 333 Melwood St., Pittsburgh, Pa. (Ass't Chief Chemist.)

G. H. Morton, % Los Angeles Pressed Brick Co., Alberhill, Cal. (Clay Mining Contractor.)

Andrew N. Outzen, % Detroit City Gas Co., Detroit, Mich. (Field Sup't Coast Sta. "J.")

Samuel Peacock, Suite 405 Wheeling Steel Corporation Bldg., Wheeling, W. Va. (Iron and Steel Technical Counsel.)

Edgar C. Rack, 26 Elizabeth Ave., Newark, N. J. (Engineer Gen. Insulation & Power Specialty Department.)

G. Ross, Saltillo Mexiko, Apartado 136. (General Manager.)

E. Roth, Zehren b/Meissen in Sachsen, Germany. (General Manager.)

Fred W. Runge, 23 Oxford St., Rochester, N. Y. (Chemist.)

Henry Holder Stephenson, 181 Jeanne Mance St., Montreal, Que., Canada. (Ceramic Chemist.)

C. S. Tietsworth, Celite Products Co., Lompoc, Cal. (Research Chemist.)

Ferdinand S. Van Doren, East Millstone, New Jersey. (Ass't Ceramist.)

O. C. Wahl, 622 S. Park Ave. (President and General Manager.)

Andres T. White, 34 Penn. Ave., Dover, N. J. (Foreman, Enameling Department.)

CORPORATION

Carr Lowrey Glass Co., Baltimore, Md. Carl G. Hilgenbery, Pres.

Dover Fire Brick Co., Cleveland, Ohio. F. C. Preston, Vice-Pres.

Fostoria Glass Co., Moundsville, West Virginia. Wm. F. Dalzell, Chemist.

Pangborn Corporation, Sand-Blast and Allied Equipment. Hagerstown, Md. Thomas W. Pangborn, Pres.

The Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Andrew Thompson, Vice-Pres.

The loyal members of the SOCIETY who are assisting the Membership Committee in their continued efforts to obtain new members are listed below:

Name	Personal	Corporation	Name	Personal	Corporation
E. E. Ayars	1		Donald W. Ross	1	
B. M. Burchfiel	1		Edward W. Schramm	1	
H. T. Coss	2		J. H. Seasholtz		1
K. H. Endell	3		F. H. Sebring, Jr.	1	
R. F. Ferguson	1		J. B. Shaw	1	
J. W. Hepplewhite	2		Thomas A. Shegog	1	
Joseph W. Hoehl	1		E. Ward Tillotson	1	
Charles J. Hudson	1		Karl Turk	1	
H. J. Knollman	1		A. S. Zopfi		2
Jacob Lindley	1		Office	5	2
Frank S. Roberts	1				
				27	5
			Deductions (2 mo.)	7	0
			Net	20	5
				Total 32	
Total Net increase for July 16 to August 15					25

1923 NET MEMBERSHIP RECORDS

		Personal	Corporation
January	12	1611	216
March	14	1710	223
April	14	1738	226
May	14	1775	233
June	14	1792	238
July	14	1808	244
August	14	1833	249
Net Gain (1923)		222	33
Same Period (1922)		220	49

WHO'S WHERE IN THE AMERICAN CERAMIC SOCIETY

Albert S. Adcock, of Columbus is now living in Worcester, Mass.

Benjamin Alderson, of The American Bottle Co., Newark, Ohio, has recently been transfered to the offices of that company at Streater, Ill.

D. H. Applegate, Jr., asks that his address be changed to the Castleton Apts., St. George, Staten Island, N. Y.

P. S. Bachman, who has been in Wooster, Ohio, has moved to 222 E. Mulberry Street, Kokomo, Ind.

Robert A. Bautz, has moved from Murphysboro, Ill., to 120 W. Kinzie St., Chicago, Ill.

Marion W. Blair, is living at 614 N. 51st St. East St. Louis, Ill., Mr. Blair is in charge of the construction of a new plant for the H & R Mining and Mfg. Co.

A. B. Christopher, who has been with the Southern Brick Co., Jonesboro, Ark., is now with the Elk River Clay Products Corporation, Northeast, Maryland.

H. T. Coss, has recently taken a position with The Celite Company, Lompoc, Cal. Mr. Coss taught in the Ceramics Dept., Rutgers College, New Brunswick, N. J., last year.

Raymond T. Fesler, a graduate of the Ceramic Dept., at Ohio State University, this year is living at 222 E. Mulberry St., Kokomo, Ind.

John Fitzpatrick, of Cincinnati, Ohio, has moved to 39 Roebling Place, Niagara Falls.

E. B. Guenther, of the Harbison-Walker Refractories Co., has been transferred from the Pittsburgh office to Room 1987–208 So. La Salle St., Chicago, Ill.

P. A. Handke, has moved from 260 So. Academy St. to 351 W. North St., Galesbury, Ill., Mr. Handke is with the Purington Paving Brick Co.

L. C. Hewitt, of the Laclede Christy Clay Products Co., has moved to 4919 Lansdowne Ave., St. Louis, Mo.

G. S. Kennelley has moved to 3205 Philadelphia, W., Detroit, Mich. Mr. Kennelley formerly was connected with the American Refractories Co., of Joliet, Ill.

Spicer S. Kenyon, has moved from 321 First St. to 2214—15th St., Niagara Falls, N. Y.

J. M. Mallory, of the Central Georgia Railway Co., Savannah, Ga., gives 233 W. Broad St. as his Post Office address.

Midland Terra Cotta Co., of Chicago, Ill., has moved from the Lumber Exchange Bldg. to 105 West Monroe St.

Henry W. B. Perry, is living at 5900 Manchester, St. Louis, Mo.

Will A. Rhodes, formerly of the Chelsea China Co., New Cumberland, W. Va., is with Albert Pick & Co., 208–224 W. Randolph Street, Chicago.

W. A. Richeux, is associated with the Isolantite Co. of Amer. Inc., Bellville, N. J.

William Turner, Trenton Potteries Co., has moved to 1511 Brunswick Ave., Trenton, N. J.

Lawrence A. Vincent, has moved from Cleveland, Ohio, to 931 Homewood Ave., Zanesville, Ohio.

ADDRESSES UNKNOWN

Members of the AMERICAN CERAMIC SOCIETY are urgently requested to forward the correct addresses of the following persons whose Journals have been returned to the office of the Secretary as a result of an insufficient or incorrect address. The address given below with the name is the last one which appeared on the official files of the SOCIETY.

Arbentz, Fred J. A., Florentine Pottery Co., Cambridge, Ohio.

Austin, G. L., American Refractories Co., Joliet, Ill.

Baker, G. V., Penn Feldspar Co., Barnard, N. Y.

Bickel, Earl A., Postville Clay Products Co., Postville, Iowa.

Butterfield, Fred H., 4906 McPherson Ave., St. Louis, Mo. Crunden Martin Mfg. Co.

Byrnes, A. Marietta, 63 Anderson Pl., New Orleans, La.

Callaghan, J. P., % Teaque Hotel, Montgomery, Ala.

Cameron, C. V., Whiting-Mead Commercial Co., 2035 E. Vernon Ave., Los Angeles, Cal.

Darlington, Homer T., Box 736, Natrona, Pa.

Dolley, Dr. Charles S., Keramoid Mfg. Co., Fort Madison, Iowa.

Fujioka, Koji, Shofu Porcelain Mfg. Co., Kyoto, Japan.

Greenwood, John L., Lehigh Sewer Pipe & Tile Co., Lehigh, Iowa.

Henshaw, S. B., Libbey-Owens Sheet Glass Co., Charleston, W. Va.

Ichijo, Mokiji, % Japanese Ambassador, Hildbrandstr. 25, Berlin, Germany.

Ivery, Sidney H., 4432 Gibson Ave., St. Louis, Mo., Hydraulic Press Brick Co.

Johnson, J. William, 4148 Langland St., Cincinnati, Ohio, Clay Salesman, with National Sales Co.

Kitamura, Y., Shofu Kogo Kafushiki Kaisha (Shofu Industrial Co., Ltd.), Kyoto, Japan.

Knote, J. M., Mines Dept. L. S. Corporation, Sault Ste. Marie, Ont., Canada.

Leahy, T. Arthur, 5490 Ellis Ave., Chicago. Ill., A. P. Green Fire Brick Co.

Marr, H. William, % Canadian Libbey-Owens Sheet Glass Co., Hamilton, Ont., Canada.

Mitchell, W. Leon, Rock Island, Ill., Rock Island Stove Co.

Moller, Chr. Y. Knud, 4956 McPherson Ave. St. Louis, Mo., Laclede-Christy Clay Products Co.

Nies, F. H., Hamilton Ave. and Summit St., Brooklyn, N. Y.

Okura, K., 84 Kobayashi-Cho, Nagoya, Japan, Japan Porcelain Corporation.

Pendrup, W., Coonley Mfg. Co., Cicero, Ill.

Peck, J. Clair, 4961 Neosho St., St. Louis, Mo., Laclede-Christy Clay Products Co.

Pohs, J. F., 1097 Interstate Ave., Portland, Oregon, Portland Stove Works.

Proodian, E. K., Newtown, Pennsylvania, Bucks Company.

Pulsifer, H. M., Manhattan Building, Chicago, Ill., Geo. H. Holb & Co.

Ragland, A. Nugent, 1280 West Adams St., Los Angeles, California, Alberhill Coal & Clay Co.

Reid, W. H., 10 Stanley Pl., Yonkers, N. Y., Consolidated Gas Co. of New York.

Rennieburgh, Cedric L., A. C. Spark Plug Co., Flint, Mich.

Thompson, E. J., 2507 Townsend Ave., Detroit, Michigan, Detroit Stove Works.

Villalta, John F. R., Apartado No. 65, Barcelona, Spain.

Vodick, William J., 1733 Lake Ave., Wilmette, Ill., Chicago Hardware Foundry Co.

Weidman, Frank E., 38 S. Dearborn St., Chicago, Inland Steel Co.

Winkleman, E. J., Pittsburgh, Pa., American Refractories Co.

THE 1923 SUMMER MEETING
TOLEDO—DETROIT—FLINT
AUGUST 8-11

In the memories and in the lasting impressions of one hundred and forty seven attending members, the 1923 Summer Meeting of the AMERICAN CERAMIC SOCIETY is now a valued and pleasant record.

In the special cars in which the party traveled the sixty miles from Flint to Detroit, eighty-eight were on their feet uncovered and at attention for five minutes on Friday at 4 P. M. in grateful memory and honor of Warren G. Harding. The cars were still, silence prevailed, thoughts and pulse beats alone continued on. The reflections of each during that brief while were of the unselfish and full-time service with which our departed president had won the personal allegiance and sympathies of men and women the world over. He was our faithful servant, faithful in all details of the trust of his official position. He shirked not, but labored with unusual diligence and prayerfulness. His is now a record of labor well done and richly compensated. He profited most because he served well.

Allegiance to and prayers for the success of our new leader, Calvin Coolidge is and will continue to be in the hearts of us all. We are going on with the same fortitude and hopes as before.

Sixty-nine persons were guests of the Toledo hosts on Wednesday, August 8th. Of these sixty-nine, nine were visiting ladies. Messrs. A. S. Zopfi and W. H. Hess extended the greetings for the Toledo manufacturers. They provided the automobiles, directed the routing of the different groups to the factories and were the hosts at a most enjoyable luncheon at the Toledo Yacht Club. The Edward Fords Plate Glass Co., the Owens Bottle Glass Co., and the Buckeye Clay Pot Co., threw wide open their factory doors to the party. Guides explained in detail the processes and process control. They invited questions and freely gave information.

Thirty-six of the party took the afternoon boat to Detroit. The day was ideal. The Maumee River teemed with commercial and pleasure boating. Lake Erie was calm. The most interesting was the Detroit River. This is a winding river broken by islands, and the banks of which are lined with richly developed estates and immense factories. Large heavily laden vessels of commerce and speeding pleasure yachts coursed the river's surface, and airplanes were in the air above. It was a superb and restful trip. Friendships were made and notes compared. A more profitable and pleasant "section Q" was never held.

The Detroit committee met the delegates at the wharf and at the trains with buses. On arrival at the Hotel Wolverine each delegate found that he was already registered and his room key in the hands of the local committee. It was in this attentive detail that the local committee cared for every want of the delegates throughout the entire trip. Morning room calls with information of the days schedule made for readiness to start each trip on the dot of the appointed hour. Thanks to Frank H. Riddle, chairman of the general committee and in charge of the Detroit excursions and to Taine G. McDougal and his assistants in Flint, every appointment was kept on scheduled time and yet with maximum comfort and attention to the desires of the delegates.

The program as announced was carried through in detail. It is only of four occasions that special mention will be given. Record has already been made of the delightful luncheon at the Toledo Yacht Club given by the Toledo hosts. Ninety-eight persons enjoyed a chicken dinner on Thursday noon given in the plant of the Champion Porcelain Co. Friday noon, seventy partook of a beefsteak luncheon given by the A. C. Spark Plug Co., in Flint. These three luncheons were enjoyed at the time but the courtesy and good will of the hosts will always remain in the memories of the guests.

Ninety-two persons sat down to a most excellent banquet Friday evening. The most memorable and profitable part of this Friday evening occasion was the illustrated talks by Mr. C. E. Ball of the Square D-Co. on "Modern Pottery Methods" and by Dr. J. A. Jeffery on "Tunnel Kiln Control Methods." The Square D-Co., manufactures insulators. They purchased an old factory and modernized its arrangement and equipment. The Champion Porcelain Co., under the technical direction of Dr. Jeffery has

adapted and adopted every known control devise whereby exact conditions of manufacturing and burning are at all times maintained. These two lectures were listened to with rapt attention and profit.

While it was no startling revelation, yet it was the frequent topic of conversation that each of these rival concerns, the Champion Porcelain Co., and the A. C. Spark Plug Co., should invite and cordially welcome the technical and operating men of their respective firms. The most cordial attention and freedom from restraint was extended by each of these concerns to the visiting men from its business rival.

This same cordiality and freely giving of manufacturing information even to exchanging of recipes was the rule without an exception in all of the enameling plants visited. The Detroit-Star Grinding Wheel Co., told of what and how grinding wheels were made. The Ford Co., not only gave the batch that was being used that day but gave detailed information on methods and cost of continuous pour plate-glass making. Ours was the first visiting party allowed in the new plate glass plant of the Ford Co., and here the visiting delegates from other plate glass companies were given especial attention some of them remaining longer to make a more thorough study of the novel and very successful method here employed. This freedom and welcome to delegates from rival concerns was particularly notable at all the plants visited.

All in all, the 1923 Summer Meeting was a huge success; efficiently conducted and productive of valuable information and valued friendships.

Notes

THE FORD PLATE GLASS BATCH

Sand	400.0
Soda ash	130.0
Limestone	118.0
Salt cake	24.0
Cullet	150.0
Arsenic	1.8
Charcoal	1.3

Attending Delegates

Mr. and Mrs. August Staudt, Miss Augusta Staudt, Perth Amboy, N. J.
Thomas A. Shegog, Sebring, Ohio.
George A. Balz, Perth Amboy, N. J.
George Simcoe, Trenton, N. J.
James A. Aupperle, Middletown, Ohio.
Mr. and Mrs. A. W. Kimes, Pittsburgh, Pa.
Mr. and Mrs. Frank G. Roberts, Baltimore, Md.
Ralph E. Seasholtz, Reading, Pa.
Mr. and Mrs. D. W. McNeil, Cincinnati, Ohio.
Carl G. Hilgenberg, Baltimore, Md.
Fred E. Jewett, Muncie, Ind.
L. E. Riddle, Jr., Metuchen, N. J.
Emery W. Jones, Perth Amboy, N. J.
Robert F. Ferguson, Pittsburgh, Pa.
Ralph F. Brenner, Rochester, Pa.
Charles J. Hudson, Worcester, Mass.
I. B. Laud, Worcester, Mass.
C. S. Linder, Creighton, Pa.
A. E. Korman, Kohler, Wis.
J. M. Lambie, Washington, Pa.
J. W. Wright, Charleroi, Pa.
R. Ellsworth Arnold, Pittsburgh, Pa.
J. C. Hostetter, Corning, N. Y.
R. T. Stull, Savannah, Ga.
E. T. Montgomery, Franklin, Ohio.
J. B. Lyon, St. Louis, Mo.
M. G. Babcock, Pittsburgh, Pa.
W. F. Godejohn, St. Louis, Mo.
F. A. Tobett, Middletown, Ohio.
D. M. Strickland, Middletown, Ohio.

Robt. A. Bautz, Murphysboro, Ill.
George Blumenthal, Jr., Chicago, Ill.
Mr. and Mrs. W. L. Brownlee, Toledo, Ohio.
L. L. Hunt, New York City.
Amory Houghton, Corning, N. Y.
Elza F. Heistand, Muncie, Ind.
Fred Carder, Corning, N. Y.
Mr. and Mrs. D. A. Cable, Canton, Ohio.
Mr. and Mrs. L. W. Mercer, Peru, Ind.
A. S. Zopfi, Toledo, Ohio.
David B. Gibson, Chicago, Ill.
A. G. Wikoff, New York.
E. E. Ayars, Joliet, Ill.
Robert, F. Sherwood, Syracuse, N. Y.
D. E. Foley, Chicago, Ill.
G. W. Batchell, Toledo, Ohio.
F. L. Steinhoff, Chicago, Ill.
J. W. Cruikshank, Pittsburgh, Pa.
Chas. O. Grafton, Muncie, Ind.
O. H. Day, Cleveland, Ohio.
F. A. Bailey, Toledo, Ohio.
L. E. Ells, St. Louis, Mo.
Gordon Klein, Springfield, Ill.
W. H. Hess, Toledo, Ohio.
Francis C. Preston, Cleveland, Ohio.
W. M. Clark, Cleveland, Ohio.
Fred B. Garrod, Toledo, Ohio.
Mr. and Mrs. M. A. Gesner, Ridgewood, N. J.
O. N. Earl, East Liverpool, Ohio.
F. H. Riddle, Detroit, Michigan.
James L. Jensen, Brooklyn, N. Y.
Thomas S. Mann, Portland, Oregon.
Leslie Brown, Trenton, N. J.
D. P. Forst, Trenton, N. J.
J. A. Williams, Trenton, N. J.
Jos. Schermerhorn, Trenton, N. J.
A. P. Ball, Detroit, Michigan.
H. H. Sortwell, Trenton, N. J.
A. T. Fenton, Trenton, N. J.
G. W. Lapp, Le Roy, N. Y.
F. H. Hastings, Hartford, Conn.
Ira E. Sproat, New York City.
J. H. Forsyth, Cleveland, Ohio.
T. W. Black, Oshawa, Ont. Canada.
R. M. King, Maryville, Tenn.
V. A. Stout, New York City.
J. S. Halvert, New York City.
Mr. and Mrs. J. W. Wenning, Pittsburgh, Pa.
H. W. Weber, Pittsburgh, Pa.
Theo. Lenchner, Pittsburgh, Pa.
H. T. Bellamy, Chicago, Ill.
Mr. and Mrs. Wm. K. Lucktenberg, Zanesville, Ohio.
Leroy F. Hobert, Sandusky, Ohio.
F. Gelstharp, Pittsburgh, Pa.
Wm. V. Knowles, Chicago, Ill.
A. Thompson, Niagara Falls, N. Y.
C. J. Kinsie, Niagara Falls, N. Y.
F. Merian, Pittsburgh, Pa.
C. S. Hahn, St. Louis, Mo.
Mr. and Mrs. Homer F. Staley, New York.
W. H. Ball, Muncie, Ind.
G. S. Kennelley, Detroit, Michigan.
F. W. Dinsmore, Trenton, N. J.
H. M. Kraner, Flint, Michigan.
T. G. McDougal, Flint, Michigan.
S. J. McDowell, Flint, Michigan.
P. D. Helser, Flint, Michigan.
H. F. Royal, Detroit, Michigan.
Robt. Twells, Jr., Detroit, Michigan.
R. W. Green, Detroit, Michigan.
B. A. Jeffery, Detroit, Michigan.
C. R. Moore, Detroit, Michigan.
T. R. Harrison, Detroit, Michigan.
P. G. Schad, Detroit, Michigan.
J. T. Littleton, Jr., Corning, N. Y.
F. B. Felton, Detroit, Michigan.
F. H. Williams, Buffalo, N. Y.
Geo. Dougherty, Reading, Pa.
H. S. Freeman, Detroit, Michigan.
R. C. Purdy, Columbus, Ohio.
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FALL MEETING OF THE SOCIETY

Wednesday, September 19, is the date. Grand Central Palace, New York City, the place.

Exposition of the Chemical Industries, the occasion.

A program of technical papers will be given in the afternoon Wednesday the 19th. This program, however, will not be the whole reason why one could afford to spend time and money to attend this meeting. The Exposition furnishes opportunity to acquaint one's self with sources of raw and prepared materials; with the very latest methods of and equipment for manufacturing, and with precision control methods and instruments. It also gives opportunity to meet those who are producing materials and equipment.

We know of one Ceramic concern which has profited many times the expense of sending three or four of its employees to this exposition because of the new processes and equipment which their men saw at the Exposition and which the concern has adopted.

This is a splendid opportunity to learn of the best and to get acquainted with the most helpful.

September 19, Grand Central Palace.

NOTES AND NEWS

THE FOURTH CONFERENCE OF THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

The International Union of Pure and Applied Chemistry met in Cambridge, England, June 17 to 20, 1923, under the presidency of Sir William Pope. The meeting was attended by delegates from 20 countries.

The Committee on Ceramic Products made the following report which was adopted by the Union:

(1) The Union recommends that, for technical and scientific purposes, the term "ceramic" be employed in connection with all industries manufacturing the following products:

Here follows the list which appears in the report of the AMERICAN CERAMIC SOCIETY's Committee on Definition of the Term "Ceramic."[1]

(2) The Committee recommends that there be established in each country an exact nomenclature of terms used for ceramic raw materials and manufactured products, together with exact definitions of such terms.

(3) The Committee unanimously agreed to place upon the agenda of the next meeting of the Union the question of the selection of typical or standard raw materials which could be employed for the purpose of studying the chemical and physical properties of refractory earths as well as proposed methods of testing.

(4) The Committee approved certain recommendations of M. Henry Le Chatelier and of M. Capsa concerning a proposed coöperative investigation to be carried out by the various ceramic laboratories of the world, but it suggested that the proposed study be executed on selected samples of the same set of raw materials in order that the results obtained should be strictly comparable. The Committee also expressed the opinion that the various laboratories should, if possible, reach some agreement as to apparatus for determining coefficient of expansion.

(5) The Committee expressed the hope that Prof. Henry Le Chatelier would accept the general direction of the proposed coöperative investigation in order to insure the proper coördination of effort.

[1] See *Jour. Amer. Ceram. Soc.*, **3** [7], 526 (1920).

THE NATIONAL LIME ASSOCIATION—ORGANIZED FOR EXTENSIVE RESEARCH WORK

The National Lime Association at its Annual Convention in June, has adopted a plan of organization which assures the continuation of its growing program of technical and research work and established a stability to the National organization which will make possible to establish and follow through to conclusion problems of research for the general benefit of the industry.

The National Officers and Board of Directors remain as the controlling body, directing the entire research and trade promotional program of the industry, but for the purpose of assuring a continued source of income for all departments of the Association and adding more flexibility to the local field promotional work, the program has been divided into two separate departments; first, the National program of technical research, publicity and National promotion; second, local trade promotional work by men in the field, sub-divided and directed from two Division offices with headquarters located at Washington and Chicago.

The members of the Association have agreed on basis of dues for a period of two years, which will afford the National program of technical research work a larger working budget than has been heretofore available, and the members in both the Eastern Division and the Central Division have agreed on a basis of additional dues which allows for a considerable increase in local field promotional work in the two Divisions.

The Lime Association loses the able leadership of Mr. Charles Warner, who has served as its President for the last four years, and who has been primarily responsible for bringing the work of the National Association to its present high standard.

The new President, Mr. George B. Wood, is President and General Manager of the Rockland and Rockport Lime Corporation, of Rockland, Main. He is a technically trained engineer, having received his degree from the Massachusetts Institute of Technology, has been an active Director of the National Association, and has added much to the lime industry in the way of technical advancement. He is a most enthusiastic believer in the future growth of the lime industry as the result of technical research and development, and is happily chosen as a successor to Mr. Warner.

Mr. William R. Phillips, the former General Manager of the Lime Association, has resigned to take the position of Vice President and General Manager of the American Lime & Stone Company. The Headquarters Office and organization is now working under the management of Mr. Burton A. Ford, Acting Secretary, who carries along the work well qualified by his experience during the last year as Mr. Phillips' assistant at the Washington office. Mr. Ford is a technically trained man, receiving his degree from the University of Maryland. Prior to joining the Association staff he was a Division Manager of the Virginia-Carolina Chemical Company and Secretary-Treasurer of the Bryant Fertilizer Company.

Dr. M. E. Holmes has resigned from the technical staff of the Association, and Dr. G. J. Fink has been appointed Chemical Director. Dr. Fink is a graduate of Wabash College and was for six years instructor in Chemistry at Cornell University, where he received his Ph.D. degree in 1914. He was also Professor of Chemistry at Iowa State College, and for five years prior to coming to the Lime Association was Research Chemist for the Hooker Electrochemical Company. Dr. Fink has been with the Association staff for two years, and is well qualified to assume the direction of the chemical and research problems.

In addition to work at the Association Laboratory in Washington, the Lime Association is supporting at the present time fellowships in five leading technical institutions where various special problems of investigation and research work are being carried through to conclusion. Coöperative relations also exist with other institutions where

important research on lime problems is being conducted. The increased budget for this class of work will make possible, under the two year program, the completion of the many problems on hand, and the inclusion of new important problems.

The personnel of the National Lime Association is as follows:

President	George B. Wood	Rockland, Maine
Vice-President	Fred Witmer	Woodville, Ohio
Treasurer	Milton McDermott	Knoxville, Tenn.

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GOVERNMENT ADOPTS STANDARDS FOR WHITE CHINA[1]

Three standard sets of chinaware for government use were agreed upon at a joint meeting of the vitrified chinaware manufacturers' committee and the Committee on China and Glassware of the Federal Specifications Board held recently at the Bureau of Standards. The sets adopted are: one-half thick chinaware for enlisted men's dining service as used in the Army, Navy, and Marine Corps; vitrified hotel chinaware for all government dining room service and hospital service where desired; and one quarter thick vitrified chinaware for hospital service. Drawings of the different articles are now being made so that each purchasing department and manufacturer can be supplied with a set of blueprints.

Those present at the meeting were: F. Sutterton, Maddock Pottery Co.; W. L. Huber, Onondaga Pottery Co.; L. H. Bown, Buffalo Pottery Co.; A. L. Goulding, Warwick China Co.; C. W. Read, Shenango Pottery Co.; J. A. Egleston, Fleet Corporation; G. A. Bentley, Quartermaster Corps; R. D. Kinsey, U. S. Public Health Service; B. Puryear, U. S. Marine Corps; A. E. Williams, Bureau of Standards; R. F. Geller, Bureau of Standards; F. Hazelwood, Bureau of Standards.

CALENDAR OF CONVENTIONS

American Association of Iron and Steel Electrical Engineers—Buffalo, N. Y., September 24–28, 1923.

AMERICAN CERAMIC SOCIETY (Annual Meeting)—Atlantic City, Feb. 4, 5, 6, 7, and 8, 1924.

AMERICAN CERAMIC SOCIETY (Exposition Meeting)—New York, September 17–22. Wednesday, September 19, is Ceramic Day.

American Chemical Society (Fall Meeting)—Milwaukee, Wis., September 10 to 14, 1923.

American Electrochemical Society (44th Meeting)—Dayton, Ohio, September 27–29, 1923.

American Face Brick Association (Southern Group)—West Baden, Ind., November, 1923.

American Gas Association—Atlantic City, October 15–20, 1923.

American Institute of Electrical Engineers—Del Monte, Calif., October 2 to 5, 1923.

American Society of Sanitary Engineers—Davenport, Ia., September 10–13, 1923.

Common Brick Manufacturers of America—Los Angeles, week of Feb. 11, 1924.

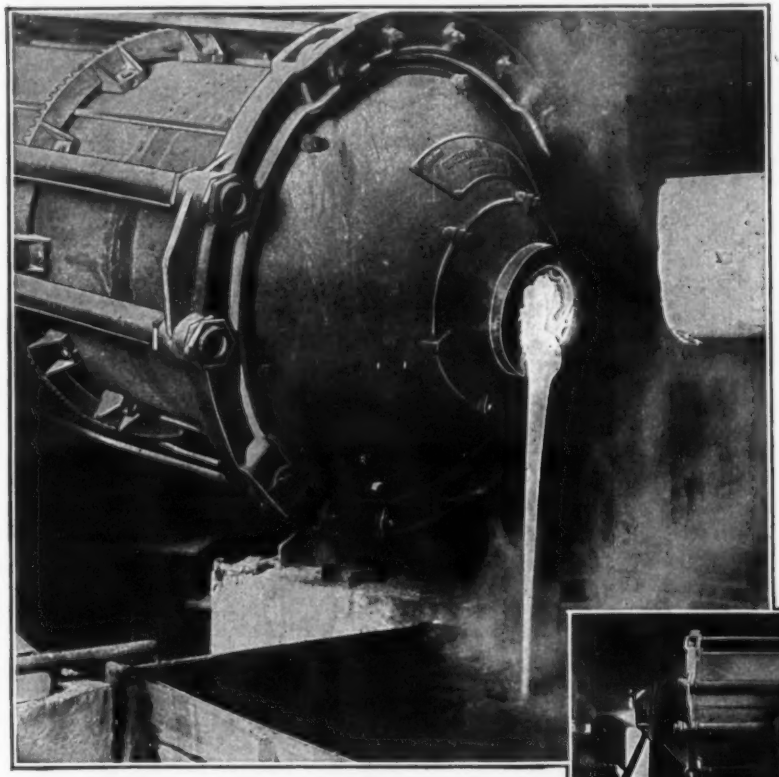
National Exposition of Chemical Industries—New York City, September 17–22, 1923.

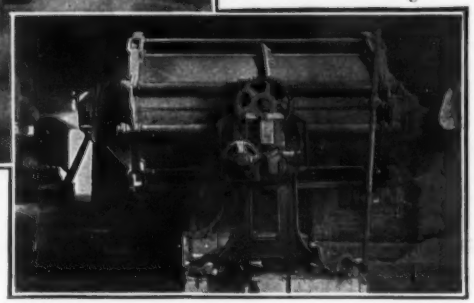
National Safety Council—Buffalo, N. Y., October 1–6, 1923.

New York Hotel Association—New York City, November 19–24, 1923.

Power and Mechanical Engineers—New York City, December 3–8, 1923.

[1] Received July 26, 1923.





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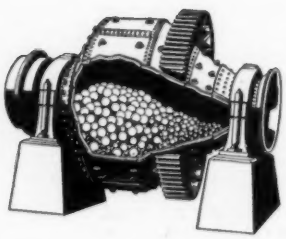

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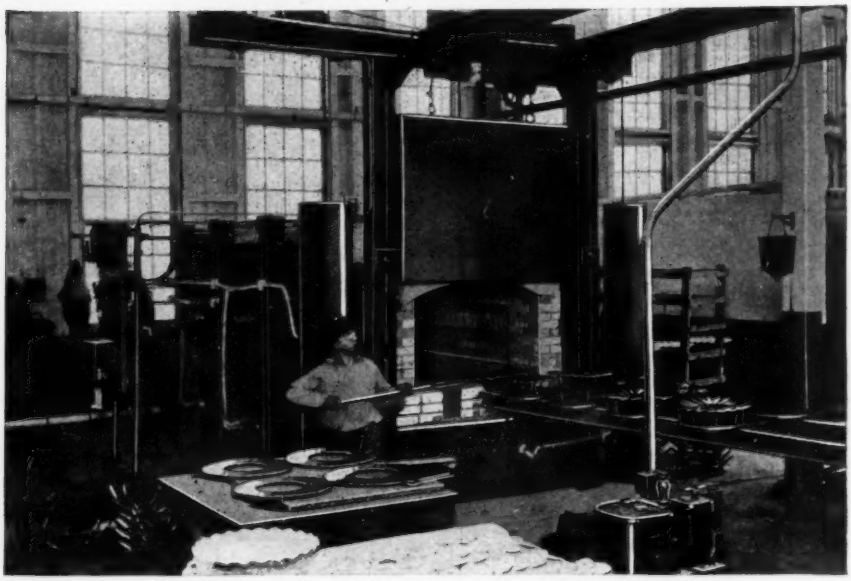

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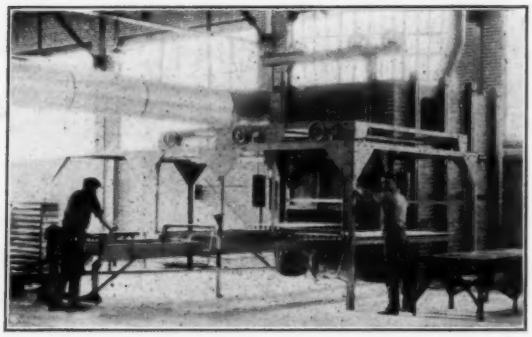

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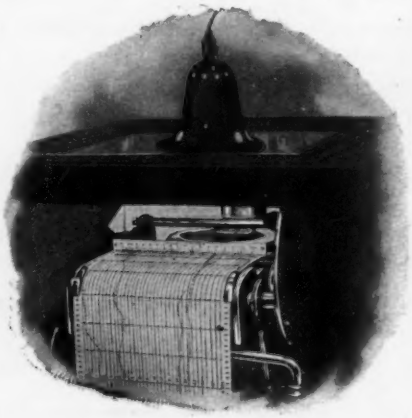

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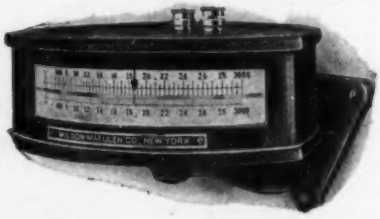

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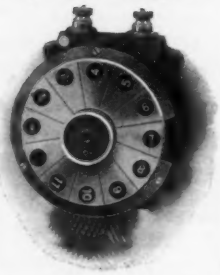

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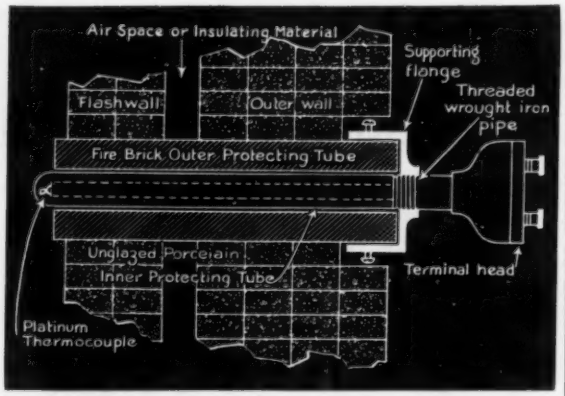

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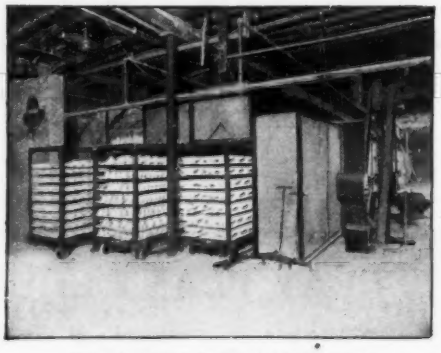

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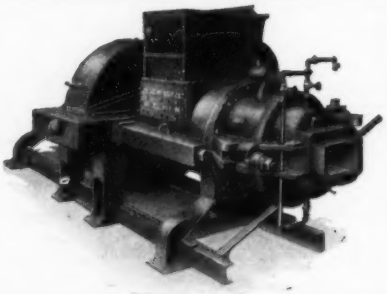

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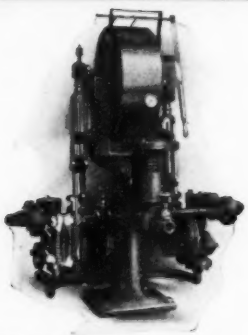

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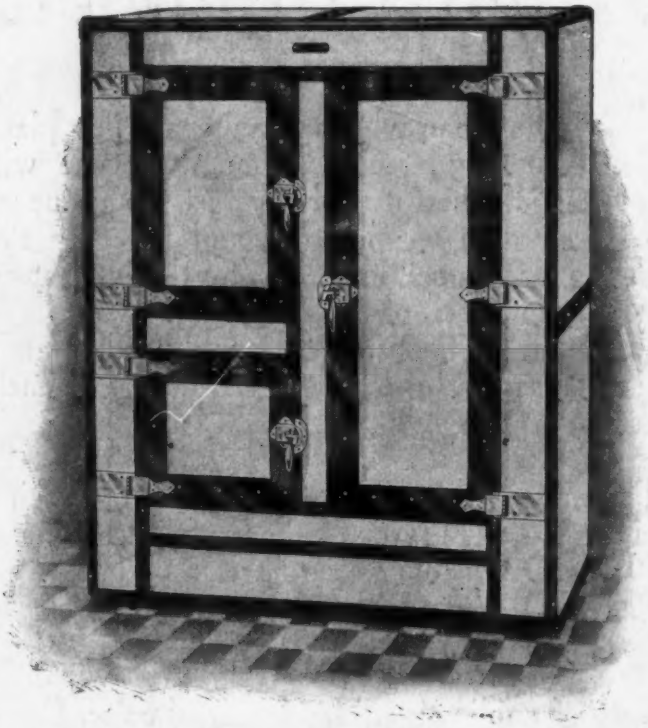

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